AMERICAN ENGINEER
CAR BUILDER AND RAILROAD JOURNAL.

MAY , 1897.

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The United States Sea-Going Battleship "Iowa."

On April 7, 1897, the United States battleship *Iowa*, built for the government by the Cramps, of Philadelphia, was given a trial trip off the Massachusetts coast. The results were all that could be desired, and the contract speed of 16 knots was exceeded by more than a knot, the average speed developed during the four hours' trial being 17.087 knots.

The *Iowa* was built under an act of Congress approved July 19, 1892, and the contract was awarded the Cramps on Feb. 11, 1893. Her keel was laid Aug. 5, 1893, and she was launched March 28, 1896. It is the first in our navy of what are termed "sea-going" battleships, the *Indiana*, *Massachusetts* and *Oregon* being coast line ships The *Iowa* is somewhat larger than the *Indiana* and class, as will be seen from the following comparison:

	Indiana.	*Iowa.*
Length on load water line	348 ft.	360 ft.
Breadth of beam, extreme	69 ft. 3 in.	72 ft. 2½ in.
Displacement in tons, normal draught	10,288	11,410
Mean draught at normal displacement	24 ft.	24 ft.
Freeboard forward	11 ft. 7½ in.	19 ft.
Normal coal supply	400 tons	625 tons
Total coal capacity	1,640 tons.	1,780 tons.
Maximum indicated horse-power contract	9,000	11,000
Speed in knots contract	15	16
Complement of officers and crew	460	486

The hull is of steel with a double bottom and close water-tight subdivisions extending up to a height of 10 feet above the load water line.

The formation of the sides amidship where they curve inboard secures the necessary freeboard without the added weight consequent to the lines being carried up with the water line fullness, gives an easier curve of stability, roomier quarters for the crew, greater sweep for the guns in the broadside sponsons, and promises efficiency of the great guns in almost any fighting condition of the sea.

For a distance of 185 feet 6 inches amipships the water line region is reinforced by a belt of 14-inch armor, 7½ feet wide, 3 feet above and 4½ feet below the water line. The forward and after ends of this belt turn inboard, and run diagonally across the ship with a thickness of 12 inches. Within the bounds of above armor and on level of its upper edge rests a flat protective deck of steel, 2¾ inches thick, and from the lower edges of the diagonal bulkheads, running forward and aft to the bow and stern, are two other protective decks, 3 inches thick, the forward one terminating immediately back of the ram.

From the top of the broadside belt and up to the line of the main deck running forward and aft amidships for a distance of 90 feet, the sides are 5 inches thick backed by a number of feet of coal. Forward and abaft the casemate armor from the protective deck up to the main deck, the outside plating is backed by a wide cofferdam filled with cellulose and divided into numerous compartments.

The main battery consists of four 12-inch breechloading rifles, mounted in pairs, in two Hichborn barbette turrets of the balanced type 15 inches thick, firing through an arc of 270 degrees, and eight 8-inch rifles in four barbette turrets 8 inches thick, mounted on the upper deck and firing through an arc of 160 degrees.

The secondary battery is composed of six 4-inch rapid-fire rifles four of which are mounted on the main deck in armored sponsons and sheltered by thick splinter bulkheads of steel, and the two remaining mounted aft on the bridge deck, sheltered by fixed shields. Twenty 6-pounder, four 1-pounder and four Gatling guns will constitute an auxiliary force, and be mounted on the main deck, on the upper deck and bridges, and in the tops of the military mast. The ship is fitted with 5 torpedo tubes, one in the stern and two in each broadside.

The propelling machinery consists af 3 double-ended boilers one 21 feet long, the other two 19 feet long, and two single ended boilers 9 feet 10½ inches long, all 16 feet 9 inches in diameter, placed in four water-tight compartments, and of two sets of triple-expansion engines, each in its own compartment. The total heating surface of the boilers is 23,950 square feet, and the total grate area 756 square feet. Each engine has cylinders 39, 55 and 85 inches in diameter by 48 inches stroke. The boilers supply steam at a working pressure of 160 pounds, and the engines are calculated to make 112 revolutions a minute. Under these conditions it was estimated that the ship would develop a speed of 16 knots an hour. With her bunkers filled and at a cruising speed of 10 knots an hour she should be able to steam about 8,022 miles, while at full speed under like conditions she should be able to cover 2,213 miles, and have an endurance of 5 days.

Nearly 100 auxiliary engines are installed for such purposes as turning the turrets, working and loading the guns, lifting and lowering the boats, raising the anchors, controlling the rudder, bringing up the ammunition from the magazines, providing fresh water, lighting the ship by electricity, making ice and preserving the fresh food, ventilating the ship, etc.

The conning tower is of steel 10 inches thick and through the armored tube leading below there is means of communication to every important station essential to control in action.

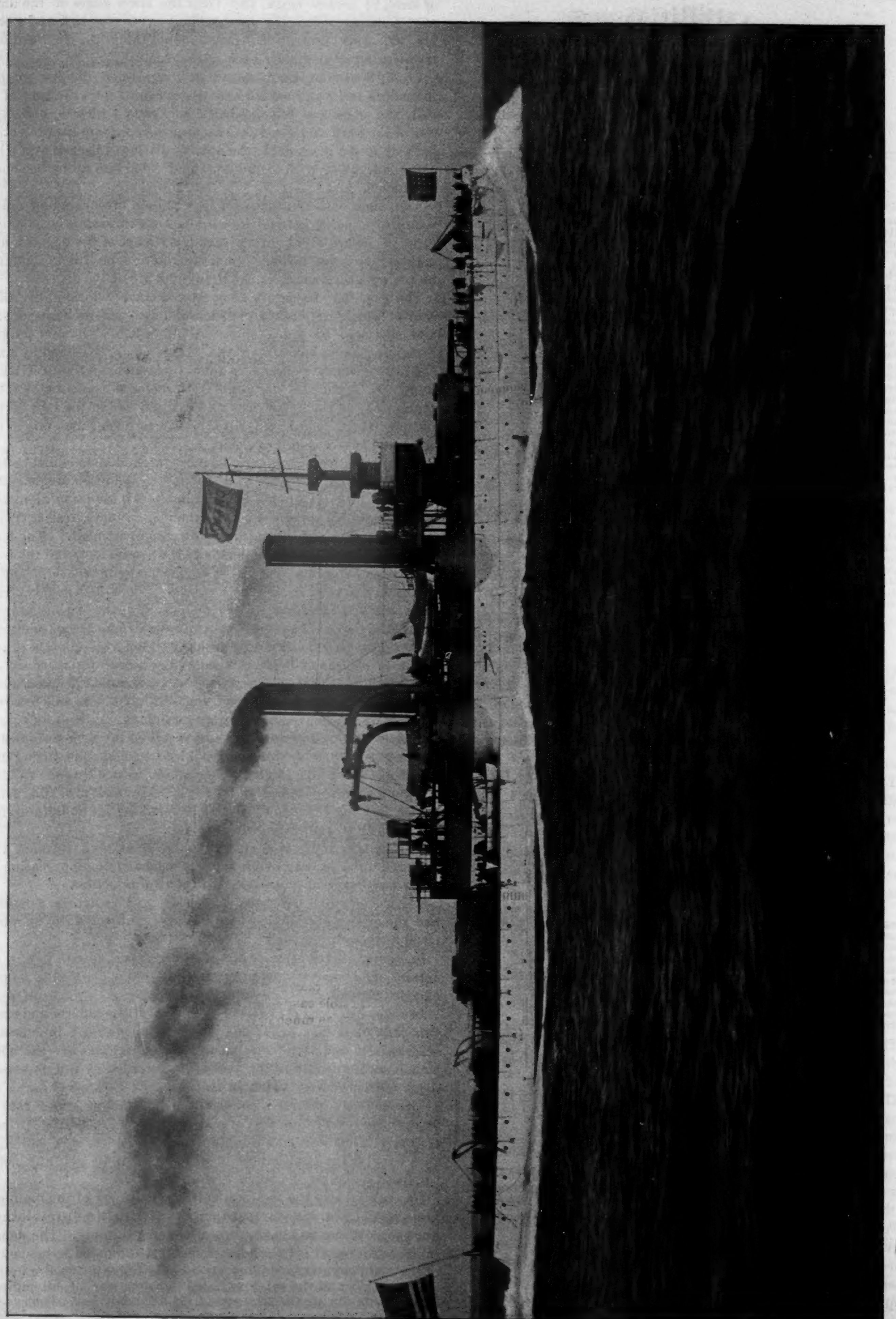
The use of wood has been dispensed with wherever possible, and the major part of that used has been subjected to an electrical fireproofing process of tried efficiency.

In armor distribution, scope of fire, possible speed, power of battery and sea-keeping properties the ship is claimed to be unexcelled abroad.

In regard to fittings to secure comfort for the officers and crew this ship does not differ materially from the coast line battleships save in one particular, but that an important one—the additional accommodation for the crew afforded by the forecastle deck. This is a very valuable feature.

The contract offered a bonus to the contractors at the rate of $50,000 for every quarter of a knot over the required 16 and the vessel thus earned a premium of $200,000 for her builders. This vessel is the last of those in which the builder gets any bonus for speed in excess of contract requirements.

On the trial trip the total indicated horse-power of the main engines was 11,834, the starboard engine making 108.61 revolutions and the port engine 110.51 revolutions per minute. The boiler pressure averaged 161 pounds. The total indicated horse-power of the main engines, including air, circulating and feed pumps, was 11,933.13 and the total indicated horse-power of all engines in operation during the trial was 12,104.8 horse-power. The speed, as already stated, was 17.087 knots.



THE UNITED STATES SEA-GOING BATTLESHIP IOWA ON HER TRIAL TRIP, APRIL 7, 1897.

Built by the Wm. Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.

The Cost of Operating Compressed Air Cars in New York City.*

The 125th street line of the Third Avenue Railroad has a length of 10,854 feet, making the round trip 4.11 miles, over which cable cars are operated at intervals of 2¼ minutes. Air cars were substituted for two of these cable cars, the schedule calling for 19 round trips each, or 78.09 miles per car, or a daily service of 156.18 miles besides 1.14 miles of switching to and from the car-house and street tracks, making the total distance covered daily 157.32 miles. Each car runs from 12.50 to 16.67 miles on a single charge of air. The switching referred to is unavoidable in operating this service, owing to the arrangement of the car-house in relation to the street tracks, it being some distance from the terminal of the road.

During a portion of the time only single service was performed, as at present, so that the total average mileage per day from Aug. 3 to March 3 was 125.16 miles, and the total distance covered 23,030.5 miles, and the total number of passengers carried 137,386. The cars have been operated every week day, but are not run Sundays.

In the following statement of operating expenses, the coal and water items include all that has been used at the compressing plant during this period, and the labor account includes, in addition to the operating employees, a night watchman, record keeper, and also switchman for a portion of the time. It must also be borne in mind that the fires are kept under boilers for 24 hours, although the compressor runs only 7 hours daily.

Actual average cost per car-mile for entire period—7 months—125.16 miles per day:

Coal	$0.056
Water	.010
Oil and waste	.001
Power plant labor	.126
Conductor and motorman	.060
Repairs car equipment	.003
	$0.2586

Average present cost per car-mile, while one car service performed—78.09 miles per day:

Coal	$0.0675
Water	.0113
Oil and waste	.0017
Power plant labor	.0883
Conductor and motorman	.0608
Repairs, car equipment	.0038
	$0.2284

Average present cost per car-mile with two car service—156.18 miles per day:

Coal	$0.0433
Water	.0103
Oil and waste	.0013
Power plant labor	.0833
Conductor and motorman	.0608
Repairs	.0028
	$0.2018

If the proportion of labor actually utilized in this service is considered, the expense would only amount to $0.1791 per car-mile at present.

Present number of employees is six, besiders conductors and motormen.

The reason for the present cost of operation being lower than the average for entire period is that the number of employees has been reduced, in addition to a less air consumption by the car. The number of employees at present is, however, sufficient to operate a 15-car service, so that the proportion of labor charges per car-mile is still very high.

At a recent conference of several engineers, who investigated the cost of operating the American Air Power Company's system in behalf of a street railroad now operating a large number of cars at intervals of one minute, it was determined after careful examination, and agreed that for the items above enmerated the cost per car-mile would in no event exceed $0.085, and that with a large equipment of cars in service, like that performed on 125th street, the cost would only be $0.0756 for the same items now costing 0.2018, while operating the two-car service. This would make the total operating expense of such a road about 12 cents per car mile.

In the recently published report of the operating expenses of 22 electric roads in Connecticut for 1896, the West Shore Street Railway Company, West Haven, is reported as operating precisely the same mileage, namely 411, with the same number of cars in service, having, however, only five employees, and the average cost of operation per car-mile is shown as $0.2991.

In the published report referred to, the average cost of operation per car-mile of the 22 roads given is $0.1444, and in the 20 roads having the items of motive power and line repairs given, the average cost appears as follows:

Motive power, average	$0.02816
Line	.00270
	$0.03086

The average consumption of free air per car-mile for the seven months' service of air cars on 125th street has been 4.77.7 cubic feet. During the last week the average consumption of free air per car-mile was only 414 cubic feet, and many of the trips were made on considerably less than 400 cubic feet. Assuming the average consumption of air per car-mile can be be kept as low as at the present time, the average cost of motive power per car-mile would range from $0.0124 to $0.027, or an average of $0.0197, and even if 477.7 cubic feet, the same as averaged for the past seven months in regular service, the cost per motive power per car-mile will range from $0.014 to $0.032, or an average of $0.023.

At the 125th street compressing plant the engine is operated only about seven hours daily, while the cars perform a 12-hour service from a 7-hour station duty.

* From a letter by Mr. E. E. Pettee, Engineer for the American Air Power Co., to Compressed Air.

Specifications for Malleable Iron Castings.*

The rapid growth of the use of malleable iron castings in car and locomotive construction has been brought about principally through constant and material reductions in their selling cost; the former great difference in cost between gray and malleable iron castings has largely disappeared. There is still an average difference of about one and one-quarter cents per pound, but this difference quite disappears in the net costs, a malleable casting of a given pattern weighing sometimes 60 per cent. less than the corresponding gray iron casting. This great slump in malleable iron prices has benefited the purchasers at the expense of the manufacturers. It is true that increased and improved facilities have cheapened the cost of production, and the stronger companies have been able to buy raw materials at lower prices. But there is a danger now that purchasers will be made to suffer unless they protect themselves by rigid requirements as to quality.

In the making of good gray iron castings there is a greater latitude in the selection of pig and scrap and of mixtures, than in making malleable iron castings. In making malleable iron castings greater care is necessary in melting, molding and rapping. As they contract in cooling after molding nearly ¼ inch in one foot, and as they expand in annealing ⅛ inch in one foot, two movements are given to the molecules of iron, and this must be taken into consideration all through the process of manufacture, from the selection of the different kinds and grades of pig and scrap, through the mixtures, melting, molding, packing and annealing; and particular care is required in making patterns to distribute the metal in as nearly as possible uniform masses.

In cleaning by tumbling, or otherwise, greater care is required than with gray iron castings because the heat of annealing "burns on" any sand not removed in cleaning. This is a serious matter if the castings are intended to fit over other parts and in castings which must be galvanized, because the zinc does not deposit upon the sand. Pickling does not always remove the "burnt on" sand. As dependence is placed not altogether, but largely, upon the "skin" of malleable castings, the cross-section at any point should be such as to give as much outside surface as possible.

In submitting these specifications it is not expected that they will be accepted as complete or free from flaws. It is hoped that discussion will follow with the object of producing a set of specifications under which malleable castings, for railroad uses particularly may be purchased and thus avoid the evils to which reference has been made. It is not thought well to control the manufacturers in way but in the results, unless it might be, in selecting whether the iron shall be cupola or air-furnace melted.

The practice that is followed in gray-iron work in casting a test piece in the same mold with the casting proper can hardly be followed in getting malleable iron test pieces. The condition of gray iron castings is supposed to be uniform throughout a given casting or in any number of castings from a variety of patterns representing thick and thin sections, while in malleable castings the annealing is most effective on thin sections. Therefore, a solid test piece of malleable iron would hardly represent a lot of malleable castings

* From a paper by C. L. Sullivan, read before the Western Railway Club.

from a variety of patterns. These are the principal reasons for recommending that test pieces shall be taken out of a finished casting, one or more pieces from different castings (patterns) to be taken at the option of the inspector.

In 1891 and 1892 a committee of the Master Car Builders' Association reported the results of some tests on specimens of malleable iron castings. The finding of the committee was for a tensile strength of from 25,000 to 34,000 pounds per square inch. Since then a considerable advance has been made and we are justified in expecting better things. The figures for tensile strength that I will recommend are not as high as one manufacturer has expressed a willingness and ability to guarantee. The specifications submitted for discussion and possible revision are as follows:

TENSILE REQUIREMENTS.

At the opinion of the inspector, one, two or three castings of either one or different patterns shall be selected from each 2,000 pounds of finished product. From one or all of the castings thus selected test pieces shall be cut and prepared, one from each selected casting. The position in the casting from which the test piece shall be cut is to be determined by the inspector. The size of the test piece shall be, as nearly as possible, such as will give, when the piece is prepared, a uniform clear length of 4 inches between the grips of the testing machine, and such as will give as nearly as possible a cross-section area of one-half square inch. Tests of one or each of the pieces thus prepared shall show a tensile strength of not less than 40,000 pounds, and not more than 47,000 pounds per square inch. The elongation and reduction of area measured after fracture shall be distinctly noticeable as indicating some degree of ductility and should be at least 1.5 per cent. for each. Should the average of three tests show a tensile strength below 43,000 pounds; and coupled with this, if ductility is not plainly discernible, the inspector shall have the option of repeating the test.

TRANSVERSE REQUIREMENTS.

Besides the tensile tests, transverse tests shall be made as follows From the same castings or others at the opposition of the inspector, one, two or three test pieces shall be prepared, giving a length of 12 inches between centers of supports and having as nearly as possible a cross-section of 1 inch square. If there should be any difference in the dimensions of the sides, the piece should be set in the machine with the greater dimension vertical.

The supports shall be 12 inches apart, center to center, and of the usual shape for making transverse tests of gray-iron castings. Tests of one or each of the test pieces thus prepared shall show an ultimate transverse strength of from 3,900 to 4,800 pounds per square inch, and deflections from 0.35 to 0.65 inch. The average breaking load for any number of tests should be about 4,300 pounds per square inch and the average deflection about 0.5 of an inch: this for specimens of the sizes recommended and for a metal of the characteristics suitable for car castings.

The fractures in both tensile and transverse tests should be fine grained and uniform; blow holes should be absent; bright edges like the chill in chilled castings should generally show distinctly at the edges; the center should generally appear almost as dark as burnt iron. No great dependence, however, can be put upon an examination of the fracture in determining the quality of malleable castings, further than seeing that castings are of uniform fine grain and free from blow holes, as the fracture will vary in appearance according to the size of section.

BENDING AND TORSIONAL TESTS.

Malleable castings which successfully pass the above requirements in tensile and transverse tests will generally successfully pass bending and torsional tests of equivalent severity. Reasonably thin sections, about $\frac{3}{16}$ to $\frac{5}{16}$ inch thick by about 1 to 3 inches wide, should bend over on themselves around a circle at the bend equal in diameter to twice the thickness of the piece and back again straight. And in torsion a thin piece of uniform dimensions, or nearly so, should twist once around without fracture. It only require proper mixtures and proper annealing, coupled with care in other particulars, to make malleable castings that will weld on themselves; that will draw out to a knife edge on an anvil under a hammer; that will temper and cut soft iron like a cold chisel. Such castings, however, cannot be had at the prices at which some malleable castings are quoted, and probably such qualities are not required in car castings.

Tests for Steel Tubes for Thornycroft Water Tube Boilers.

The specifications for the steel tubes used in the construction of Thornycroft water tube boilers have been furnished the Journal of the American Society of Naval Engineers, by Mr. John Platt, of New York, the agent in this country for Messrs. Thornycroft & Company, from which publication we take the following:

Tests for Boiler Tubes.—The boiler tubes are to be solid drawn, finished cold, so as to remove all traces of the hot process, and leave perfectly smooth surfaces inside and outside.

The tubes are to be perfectly straight, smooth, cylindrical, of uniform sectional thickness, and of equal diameter throughout, excepting as specified below; they are to be free from any scale, longitudinal seaming, grooving or blistering, either internally or externally, and they are not to be oiled, varnished or painted.

The ends ot the tubes are to be pressed or squeezed up for screwing in a die or press (not by hammering or upsetting). Any case discovered of a strip being welded on will render the whole liable to rejection. The tubes are to be made from acid or basic open-hearth steel, which material is to stand the following tests:

	Ultimate tensile strength.		Elongation in a length of 2 inches, per cent.
	Not more than, tons.*	Not less than, tons.*	
(*a*) Annealed pieces cut from the forging from which the tubes are to be made	24	21	33
(*b*) Annealed pieces cut from the tubes...	26	..	27

*Tons of 2,240 pounds.

Test (*a*) is to be carried out at the works of the tube maker, and (*b*) at the works of the makers of the boilers.

Strips cut from the tubes, flattened, heated to a blood heat, and plunged into water 82 degrees Fahrenheit temperature, should be capable of being doubled over a radius of ½ inch without fracture. This test is to be carried out at the works of the makers of the boilers. Pieces 2 inches long, cut from the tubes under $\frac{3}{16}$ inch thick, are to be capable, when cold, of being hammered down lengthwise until their length is reduced to 1 inch. The tubes themselves are to be capable of being flattened by hammering at any part until the sides are close together, for tubes under $\frac{3}{16}$ inch thick and for tubes $\frac{3}{16}$ inch thick and over the sides are to be brought to a distance apart of twice the thickness of the material of tubes, in each case without fracture. The ends of the tubes under $\frac{3}{16}$ inch thick are to admit of being expanded cold by a three-roller expander, worked in a series of three tube holes, and hot by a solid drift to the following increases of diameter:

With roller expander fitted with three rollers (cold), 12.5 per cent.; with solid drift (hot), 20 per cent.

Tubes $\frac{3}{16}$ inch in thickness and over are to admit of being expanded hot and cold to half the increase in diameter required for the tubes under $\frac{3}{16}$ inch.

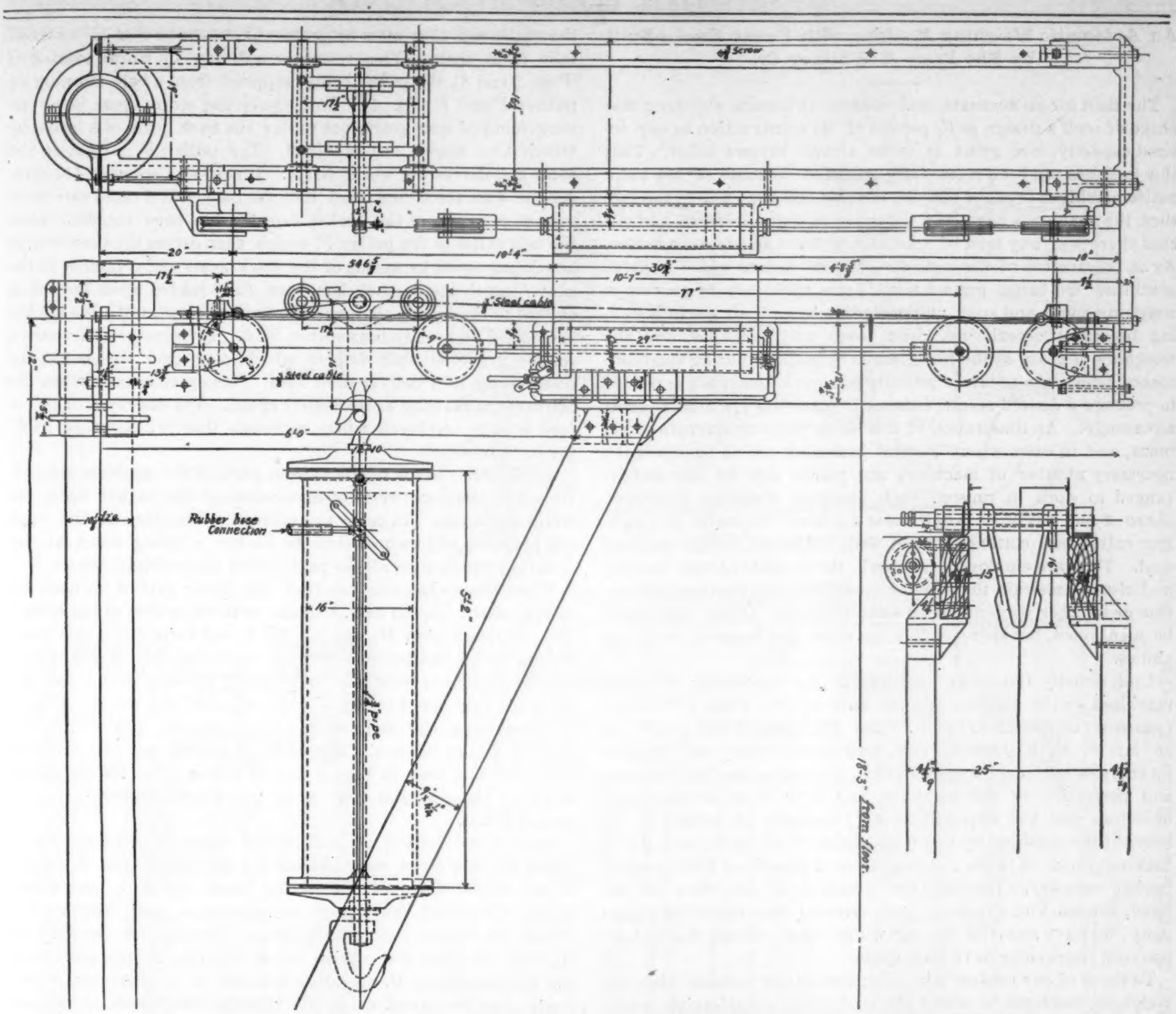
The above tests are to be carried out at the works of the makers of the boilers, and are to be applied to two per cent. of the tubes, to be selected by the examining officers, after electric galvanizing; and these tubes are to be completely destroyed for the purpose of this test. The tubes for this purpose are to be arranged in parcels of 100, and all rejected tubes are to be marked by the examining officers, so that they may be capable of identification. The failure of the tubes selected will reject the parcel of 100 from which they were taken.

Each tube must stand a test by water pressure internally of 1,500 pounds per square inch, after bending and annealing, but before electro-galvanizing, without the slightest indication of weeping. This test to be carried out at the boiler makers' works.

The failure of a large proportion of the tubes selected to stand any of the above tests in a satisfactory manner will render the whole of any delivery liable to rejection.

All tubes are to be thoroughly pickled to remove scale, and unless otherwise ordered are to be galvanized externally by electro-deposition. Each tube is to be removed from the electro-depositing bath after being immersed and subjected to the electro-depositing action for about 15 to 20 minutes. It is then to be carefully examined, and, if any defects are exhibited, the tube is to be rejected. The satisfactory tubes are to be replaced in the bath and coated with zinc to an extent of 1¼ ounces per square foot galvanized surface.

The limit of variation of weight of each tubb which will be allowed is 2½ per cent. above the weight calculated from the approved dimensions, allowing 480 pounds per cubic foot of metal. All tubes exceeding this limit, or less than the specified thickness, will be liable to rejection. All tubes which are less than the external diameter specified, or more than 1 per cent. larger than the diameter approved, will be rejected.



Pneumatic Crane for Wheel Press.—Chicago, Rock Island & Pacific Railway.

Pneumatic Crane for Wheel Press—Chicago, Rock Island & Pacific Railway.

In the accompanying engraving we illustrate a pneumatic crane recently erected over a large wheel press at the Chicago shops of the Chicago, Rock Island & Pacific Railway, the drawings being furnished us through the kindness of Mr. Geo. F. Wilson, Superintendent of Motive Power. In designing this crane the motive power department was much handicapped by the conditions in the shop, particularly in the small amount of head-room, the effect of which is seen in the construction of the trolley or carriage. The lifting of the load is accomplished by a 6-inch cylinder hung from the trolley and with a hose connection and operating valve of the usual construction for shop lifts.

The movement of the trolley horizontally by air was in the nature of an experiment. A 6-inch cylinder, double acting, was applied as shown, and by means of ⅜-inch steel rope passing over fixed sheaves hauled the trolley either direction, as desired. The pull on the carriage was calculated at 700 pounds, but it was found that the trolley could be moved only when the load suspended for it did not exceed 3,000 pounds. Subsequently an 8-inch cylinder, similar to the 6-inch one shown, was placed on the other side of the crane, and connected to the trolley in the same manner as the first one. With the two cylinders the trolley can be operated when the load suspended is as great as 10,000 pounds. The need of so much power is, in part at least, to be attributed to the small wheels on the trolley. They are only 4 inches in diameter, and have 1½-inch axles. If there were room for larger wheels the friction would undoubtedly be much less.

With the air cylinders as now applied the load can readily be moved; but there remains one difficulty which is common to many uses of compressed air. The friction of the trolley at rest is so much greater than when it is moving, that after it is once started the force of the expanding air in the cylinders causes the carriage to move a greater distance than may be wanted—that is, if the desired movement is small, and a movement of, say ¼ inch, is almost impossible to get. Hydraulic lifts of a like construction do not have this objectionable feature, as the water is practically non-expansive, and the piston does not move more than what is due to the volume of water let in. It would seem as if in such cases as this the whole difficulty would be overcome by using water in the cylinder, and air back of the water to furnish the pressure. Such a construction would not be difficult. The present construction, however, works very nicely in all but the very small movements.

It is intended to fit to this crane an air cylinder for swinging it, and then all operations will be performed by air. This cylinder will be located on the under side of the horizontal arm of the crane, and will have a double-acting piston, carrying a sheave at each end of the piston-rod. A wire rope, having each end fastened to the crane, will pass over the sheaves and make a number of turns around the pillar of the crane. Thus the crane will be swung in either direction, and as all operating valves for the three movements of the crane can be grouped together, the arrangement is a most convenient one.

An Automatic Weighing Machine with Power Feed.—Built by The Pratt & Whitney Co.

The field for an accurate and reliable automatic weighing machine of such a design as to permit of its construction in any desired capacity, is so great as to be almost beyond belief. That this field has not been more fully occupied by some of the automatic machines brought out in the past has been due to the fact that the machines have been defective in some respects, and not that there was any lack of purchasers for a satisfactory device. As an illustration of the wide diversity of uses to which reliable machines are being put we would cite their use by grocers in weighing sugar and such materials into bags, their use in weighing breakfast cereals, etc., into boxes and packages, and the weighing of grain at the mills, while in manufacturing establishments, where the accurate mixture of several materials is needed to produce a desired result, automatic machines are used to great advantage. An illustration of this is in the manufacture of cement, and in cases where several materials are to be mixed the necessary number of machines are placed side by side and arranged to work in unison, each machine weighing its proper share of the mixture. Then these machines are useful in weighing cottonseed, cottonseed meal, salt, fertilizers, broken ores and coal. They are employed to check the weights of coal received and also to ascertain the amount consumed daily in steam generation or in other ways about an establishment. Other uses might be mentioned, but these suffice to show the range of these machines.

Undoubtedly the most practical of the automatic weighing machines on the market is that built by The Pratt & Whitney Company, of Hartford, Conn., from the designs and inventions of Mr. F. H. Richards. This well-known firm has brought its energies and mechanical talent to bear upon the improvement and perfection of the machine, and now after several years of effort and the expenditure of thousands of dollars it has brought the machine up to a high standard of excellence, and is making them in sizes ranging from 2 pounds to 2,000 pounds bucket capacity. Through the courtesy of Mr. Geo. W. M. Reed, Second Vice-President and General Manager of the company, we have received the drawings from which the accompanying engravings have been made.

To those of our readers who have seen or are familiar with the weighing machines in which the bucket has considerable movement of one kind or another, such as swinging downward or tipping when full, the construction of the machine we illustrate embodies a much more attractive principle of operation and one that from a mechanical standpoint will appeal to everyone capable of appreciating excellence of design. In Figs. 1, 2, 3 and 4 we show a side elevation, two end views and a plan of a machine of 600 pounds or 10 bushels capacity, and in Figs. 5, 6, 7, 8 and 9 we give various views of an excellent counter used on the machine and also placed on the market separately by the company.

The bucket *A* in which the material is weighed is a rectangular affair with a drop bottom, and in this size of machine is 44¼ inches long, 24$\frac{5}{16}$ wide and 35 inches deep. It is maintained in an exactly vertical position at all times, and is supported by four knife edges upon the levers or weighing beams *B B*, which in turn are fulcrumed upon other knife edges on the base of the machine. These weighing beams consist of two round bars of iron extending the length of the machine, one in front of the bucket and the other behind it, with their ends turned inwardly to form weighing levers. Each piece is supported by two knife edges on the base and is limited in downward movement when the bucket is emptied by brackets, also on the base, as seen in Figs. 1 and 3. These weighing beams are designed to balance the weight of the bucket and its load, and the sliding weight seen in Fig. 3 permits of final and accurate adjustment after the machine is put together.

The material to be weighed enters the hopper *C* and falls upon a conveyor *D* composed of a pair of drive chains and a series of overlapping slats, pivoted at one edge to the chains. On the upper side of the conveyor the slats are closed, but as they pass to the under side they open by gravity as shown, so that all material falls from them. This conveyor is driven by worm gearing *G* (Figs. 2 and 3), the power being supplied from a belt running on pulleys *E* and *F* (Fig. 4). Just above the worm gear is an arrangement of spur gears, not unlike the back gears of a lathe, by which two speeds are obtained. The pulley *E* is tight on the shaft and drives the worm direct. It runs at a speed of 400 revolutions and feeds the load into the bucket at a rapid rate until over 80 per cent. of the bucket capacity has been reached, when the belt shifts to the pulley *F*, which then drives the conveyor at a reduced speed by means of the back gears and a ratchet in the gear *I*, until the bucket has been fully loaded when the belt is shifted to the loose pulley and the feeding stops, until the bucket is emptied and ready for another load. The eccentric *H* works a shaker provided with fingers, which play over the slats at the point where they deliver their load. This operates only when the conveyor is running at the slower speed. The conveyor or power feed is only employed when materials that will not flow freely are to be handled.

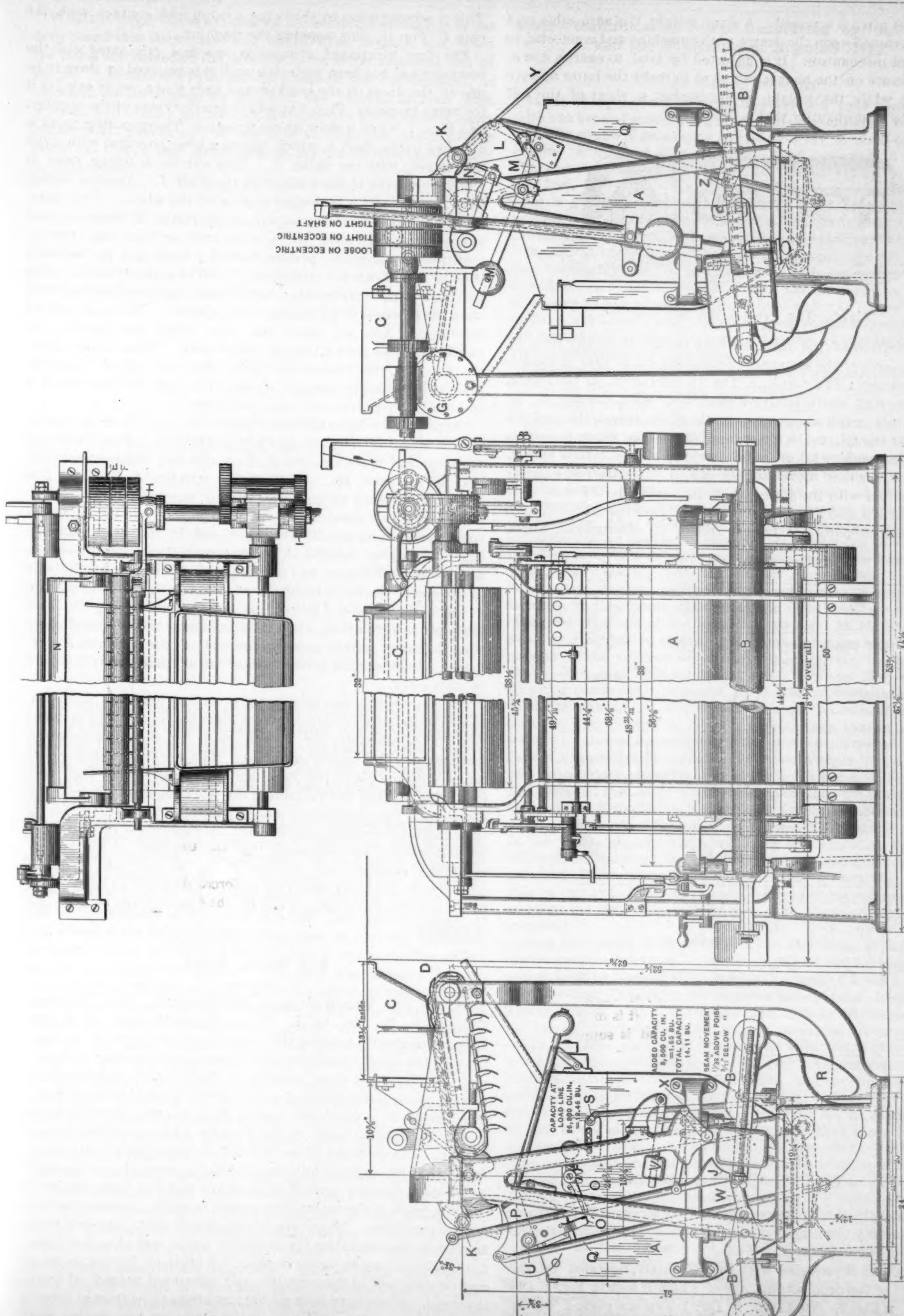
All the movements of the various parts of the machine are controlled by the small vertical movement of the bucket upon the weighing beams. In order to explain the functions of the various parts we will assume that the bucket is being filled at full speed, at which time all the parts are in the positions shown.

When the bucket has received the larger part of its load, the weight of this partial load, together with the action of the weight *M*-1 (through lever *M*, cam *L*, shaft *K* and valve rod *J*) operates to bear down the beam arm, thus carrying the bucket downward a portion of its stroke, and thereby shifting the driving belt on to the slow speed pulley *F*, thus reducing the conveyor speed and delivering the material in a small stream, and thereby obtaining a nice balance. The valve *N* is also partially dropped. (This valve is seen in Figs. 1, 3 and 4, and is for the purpose of catching the material that is in the act of dropping when the bucket is full.)

During this period of the loading operation the long arm *Y*, called the drip lever, rests against the drip-lever latch *Z*, carried on the extended arm of one of the beams, so as to have a relatively downward movement, as compared with the bucket. When the bucket load is completed, lowering the bucket very slightly, the latch *Z* is carried below the arm *Y*, thus permitting the weighted lever *M*, operating through its connections, to suddenly close the cut-off valve under the forward end of the conveyor. This instantly catches the last part of the drip stream, preventing it from going into the bucket. The same operation shifts the driving belt from the slow-speed pulley to the idle pulley *R*, and thus entirely stops for the moment the operation of the conveyor.

The rod *J* in dropping also forces down the catch *O* which holds the cam *P* (Fg. 1), and as the interlocking cam *T* is now out of the way, the shaft *U* is free to rotate, and the rods *QQ'* no longer hold the drop bottom in position. Hence it opens and discharges the load through the base of the machine. At the moment the load falls, not a part of the machine is moving except the belt on the loose pulley of the conveyor. The load once out the counterweight on the drop-bottom closes it, returning the cam *P* (Fig. 1) to the position shown. Of course the weighing levers raise the bucket at once, but until the drop door is closed tightly the machine cannot start, for until then the cam *P*, by blocking the cam *T*, prevents the shaft *K* from rotating. As soon as the bottom is closed the cam *T* is liberated and the shaft *K* is rotated by the rod *J*, which is forced up by the weighted lever *W*. By this movement the valve *N* swings up and drops into the bucket the material caught by it, the shipper throws the belt to the position in our illustration, and the bucket begins to fill again.

It is apparent that when the valve *N* drops to catch such material as falls from the conveyor after the full load has depressed the bucket, it cuts into a falling column of the material, and that portion in the air and below the valve falls into the hopper. One of the important refinements of this machine is an arrangement to compensate for this small quantity that falls into



THE RICHARDS AUTOMATIC WEIGHING MACHINE WITH POWER FEED.
Built by the PRATT & WHITNEY COMPANY, Hartford, Conn.

the bucket after it is poised. A small weight V is adjustable on a lever fulcrumed upon the frame of the machine and connected to the bucket mechanism. It is adjusted by trial to exert a downward pressure on the bucket sufficient to make the latter operate the scale while the weight in the bucket is short of the full amount by that quantity that is falling.

Fig. 5.—The Pratt & Whitney Counter.

The accuracy of the machine may be tested at any time by throwing some of the automatic mechanism out of gear in the following manner: The crank X (Fig. 1), fulcrumed on the frame, operates a rock shaft having a connection with the rod J. By moving this crank about one-eighth of its travel, the rod J is shifted far enough to be disengaged from the catch O, so that though the machine takes its full load the bucket cannot empty. The crank X is then moved far enough to throw the rod entirely out of contact with the scale mechanism, while at the same time the weight V is also lifted from the scale. Thus the load-weighing mechanism supports the bucket free of all obstructions, and is

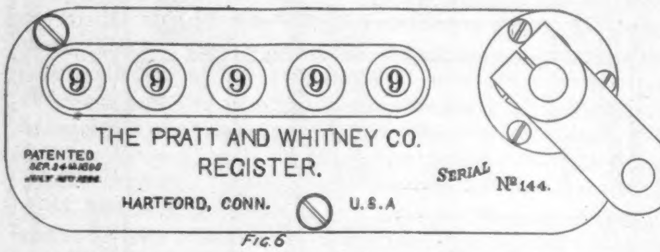


FIG. 6

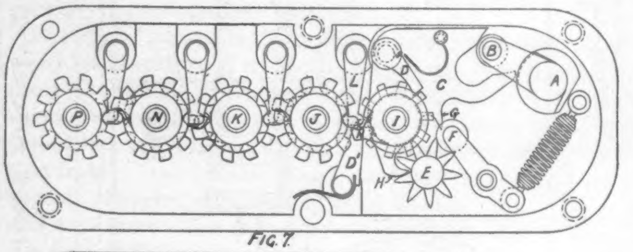


FIG. 7

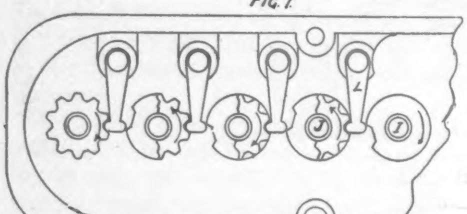


FIG. 8

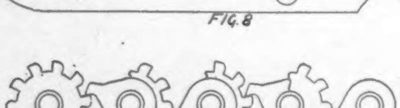


FIG. 9.

The Pratt & Whitney Counter.

free to oscillate through its entire working stroke. The operator can thus at any time satisfy himself of the accuracy of the adjustment of the machine.

The machine is provided with two Counters, operated by the movement of the drop bottom, one of which is seen in Fig. 1 and the other n Fig. 2. That seen in Fig. 1 is such a perfect device that it needs no check of any kind, but the second is one that can be set to stop the machine after a certain number of weighings. This it accomplishes by throwing a catch into contact with the cam P (Fig. 1), thus stopping the machine.

The first mentioned counter is one that originated with the company and has been perfected until it is believed by them to be one of the finest on the market, and they find a ready sale for it for many purposes. Figs. 5 and 6 are exterior views of the counter, and Figs. 7, 8 and 9 show its construction. The operating crank is attached to the shaft A, which carries a lever provided with a roll B engaging with the pallet C. This carries a spring pawl D which drives the toothed wheel on the shaft I. Another spring pawl D^1 prevents a backward motion of the wheel. The latter pawl is composed of three superimposed plates of three lengths varying from each other by $\frac{1}{100}$ of an inch, so that one, two or all three may drop into position behind a tooth and the backlash thus be kept down to a minimum. It will be noticed that the pallet also carries the escapements G and H operating in conjunction with the toothed wheel E which also meshes with I. This more refined mechanism does not come into play unless the pawls DD^1 should for some reason become inoperative. When these pawls are working, the escapement only drives the wheel E, and is practically without wear or strain. The roll F at the end of a spring-actuated lever prevents overthrow.

There are five dials, and each spindle, I, J, K, N and P, carries a spur wheel of 10 teeth, and all but P carries a driver with one tooth, so that 10 revolutions of the units dial causes one revolution of the tens, etc. Each of the spindles J, K, N and P is also provided with an ingenious locking mechanism that is simplicity itself. It consists of a disk with one notch in its circumference, as shown on spindle I in Fig. 8, and in the same plane on the next higher spindle, J, is a disk with 10 notches. Between the two is the T-shaped end of a lever, L, fulcrumed at the side of the case. During nine-tenths of a revolution of I the disk on it keeps the spindles J locked, as shown, but during the last tenth of the revolution, when it is necessary that J should move also, the notch arrives opposite the end of the lever and J is released. Each spindle is thus locked at all times when it should be stationary.

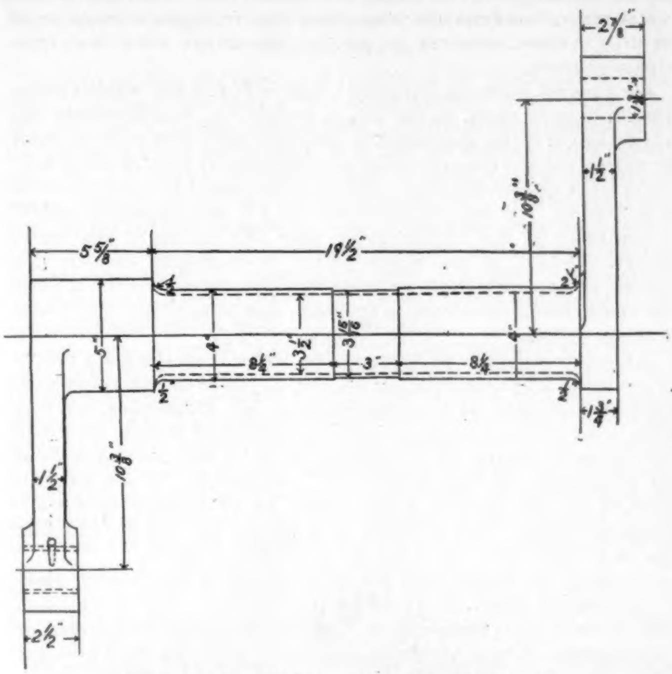
The counter is of special interest as an instrument of precision. It is manufactured on the "interchangeable system," by a plant constructed especially for it, and made by the most approved methods of watch-tool manufacture. The working parts are contained within a plain but neat and substantial case—positively excluding all dust and protecting the works against all ordinary accidents. This instrument was produced primarily for use on the automatic weighing machines. An experience of two years or more having demonstrated the practicability of the instrument, the company has adopted it for its own use, and has offered it to the trade, believing that its merits will be appreciated by all who require a reliable count of the movements of any class of machines.

Fort Wayne Notes.

At the Fort Wayne shops of the Pittsburg, Fort Wayne & Chicago R. R., Mr. G. L. Potter, Superintendent of Motive Power, has greatly reduced the wear of certain parts of locomotives by the use of bronze cast on to the parts whose wear is excessive. Engine truck wheel hubs are so treated, and with excellent results, particularly where the wheel centers are of wrought iron. The inside hub is faced and turned to a dove-tail section, after which the wheel is taken to the foundry and the bronze facing cast on. The diameter of the bronze face is purposely made much larger than the original hub, the size usually being about 12 inches, and a large wearing surface of excellent material thus obtained.

Other parts of the locomotive treated in much the same fashion are the eccentrics. These are rough-turned about one-half inch smaller in diameter than the eccentric straps, and of such a form as to hold the bronze firmly in place. A shell of bronze is then cast on each half of the eccentric and afterward turned off to fit the strap. There have been no hot eccentrics on engines so fitted, and furthermore the repairs are easily made, as lost motion can be taken up by casting a new bronze shell on the eccentric.

With the large valves so common in modern locomotives it has been found that the rockers and boxes wear rapidly, and when the boxes are babbitted the metal is liable to be squeezed out of shape. A bronze sleeve is therefore cast on the rocker shaft, as shown in the accompanying cut, and the journal and box now wear so well that an engine goes through the shops several times before wear is taken up. When this is done the box is simply bored out true, a new sleeve cast on the rocker shaft and turned to fit the box.



Rock Shaft with Bronze Bushing Cast on It.

This method of casting the bronze on to the part to be protected by it is found to be much cheaper in first cost and repairs than any other method, the labor item being very small. In the foundry special flasks are used and before casting the part to which the bronze is to be applied is warmed to a temperature of, say, 450 or 500 degrees.

It is probable that few persons have realized that the maximum pressure upon the front side of a driving box is much greater than upon the back side when the engine is going forward. And yet such is the case, for when the piston is moving forward the pressure upon the front of the box is equal to the sum of the pressure on the crank pin and the tractive effort of that wheel at the rail, and when the piston is moving backward the pressure is on the back of the box and is equal to the difference between these two forces. This fact was forcibly demonstrated at Fort Wayne recently in the case of some engines whose driving box linings were not extended down to the center of the journal, but were shortened about one inch with the hope that if they got hot they would cling to the journal much less than usual. It was found that these brasses had a marked tendency to wear toward the front, and in seeking for the reason the reason the difference in pressure front and back was noted. Further investigation has also disclosed the fact that the breakages of the driving boxes are in general more numerous on the front than the rear side.

Two of the class O eight-wheeled engines, with 18-inch cylinders, have recently been fitted with the form of exhaust pipes and nozzles recommended by the committee of the Master Mechanics' Association, and with excellent results. Where 4¼ or 4½ nozzles were formerly used, a 5-inch nozzle is now employed and the steaming qualities are improved. One of these engines recently hauled a train of ten cars, three of which were Pullman sleepers, over the division between Chicago and Fort Wayne, 148 miles, and made up 31 minutes on a schedule of 4¼ hours—a remarkable performance.

Some Possibilities of Power Generation by Gas Engines and the Utilization of Rejected Heat.*

BY REID T. STEWART.

It will be my purpose to-night to present for your consideration, with the hope of stimulating general discussion, some of the possibilities of power generation by means of the internal combustion engine. Engines of this type have been proposed to run upon almost every conceivable cycle and to consume almost every available fuel. Very few of the numerous attempts, however, to produce a practical internal combustion engine have resulted in success, the difficulties to be overcome being so great that, up to the present time, only gaseous and liquid fuels have given success.

Regarding the action of the internal combustion engine of to-day, although almost every conceivable cycle has been tried, it is a significant fact that, since the lapse of the Otto master patent in 1890 every builder of gas engines of note, so far as I have been able to learn, not already manufacturing such engines, have put upon the market engines running upon either the original Otto cycle or upon a modification of this cycle.

The efficiency of the gas engine has been very materially increased during the last 10 or 12 years. For example, the Crossly Otto engine of a certain size, as built in the years 1882, 1888 and 1894, showed absolute indicated efficiencies of respectively 17, 21 and 25 per cent., the compression pressures being respectively 38, 67 and 88 pounds. This is what should be expected since theoretically, neglecting all losses and imperfect action, the efficiency of this type of engine may be shown to equal unity minus the ratio of the absolute temperature of the charge before compression to the absolute temperature after compression. From this expression it is apparent that an increase in compression is attended by an increase in efficiency. This is also very clearly shown in Fig. 17 (from Proc. Inst. C. E., Vol. 124, Pt. 2) representing cards from these three engines plotted to the same scales of pressures and volumes. In this figure, ab represents in each case the volume of the cylinder at the end of the induction stroke. At the end of the next, or compression stroke, this volume of gases would be compressed to the volumes ac, ag and al respectively, in the engines above referred to as being built in 1882, 1888 and 1894, the corresponding compression pressures, cd, gh and lm, being, as stated, 88, 67 and 88 pounds. It will be noticed that the ratio of the area of card No. 2 to the area of No. 1 is greater than that of the corresponding volumes, bg and bc, of the charges drawn into the cylinders of the respective engines. This would imply that more work was done by a certain quantity of gas in No. 2 than in No. 1. It is also apparent that more work would be done by the same quantity of gas in No. 3 than in No. 2. As above stated the absolute indicated efficiencies, obtained by actual trial, were 17, 21 and 25 per cent. In the Hugon engine, which admitted and exploded the charge without compression, the efficiency probably did not exceed 5 to 8 per cent. It would appear from these figures, then, that compression, in this type, is a very essential feature of gas engine economy, and that the high efficiencies of to-day are due chiefly to high compression.

From the report of Mr. Victor A. H. McCowen, of Belfast, of a recent tests made by him upon an engine of 120 indicated horsepower, built by Messrs. Dick, Kerr & Company, I have abstracted the following: The engine tested was a two-cylinder, double acting tandem engine, with cylinders 13.5 and 13.75 by 20 inches stroke, and ran at 160 revolutions per minute, receiving an impulse each stroke. In this gas engine there is a nice adjustment of work done in the cylinder to the demand for power. The compression pressure is maintained constant at all loads, and for light loads the pressure is well maintained throughout the stroke. The fact that the compression pressure remains constant for all conditions of loading would suggest, as is in fact the case, that the quantity of air supplied to the cylinder on each induction stroke is always the same. This nice graduation in the impulses, then, is obtained by varying the quantity of gas admitted to the cylinder. The manner of doing this requires explanation, since, as is well known to those who have had experience with gas engines, the proportion of gas in the mixture does not permit of great variation. In this engine, however, as the demand for power gradually decreases, the governor responds by admitting the gas to the cylinder later and later in the charging stroke, the gas even at full power being preceded by a considerable quantity of air. It would appear from indicator cards that stratification did actually exist in

* From a paper read before the Engineers' Society of Western Pennsylvania, Feb. 16, 1897.

the cylinder of this engine, that is, there was at the end of the compression stroke a portion of rich explosive mixture in the combustion space, the rest of the cylinder being filled with air. This engine ran with as great regularity as a double-acting simple steam engine. The ignition was by hot tube controlled by a timing valve, and the engine was started by compressed air.

UTILIZATION OF WASTE HEAT.

From the results of a number of tests made upon modern gas engines, ranging from 20 to 100 horse-power, it would appear that from 72 to 80 per cent. of the heat supplied to the engine is discarded. Neglecting the radiation losses, they being quite small, we can then credit the jacket water and the exhaust gases with carrying off, on the average, about 75 per cent. of the heat supplied

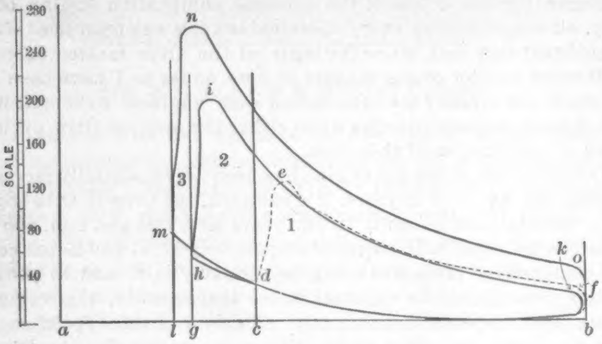


Fig. 17.

to the engine. The discarded heat amounted, by actual test, to 7,400 British thermal units per indicated horse-power hour in the Crossly-Otto engine referred to in this paper, and would probably be 7,200 British thermal units per indicated horse-power hour in a similar engine of 100 horse-power capacity. Upon this assumption, then, an engine of 100 indicated horse-power, while running continuously at full load, would discard to these two sources heat at the rate of 720,000 British thermal units per hour. Using average values obtained from results of tests upon four engines, I find that of this 720,000 British thermal units, 338,600 would probably pass into the jacket water, and the remaining 382,000 would pass off in the exhaust gases. The temperature of the exhaust gases in this case would probably not be less than 1,700 degrees Fahr.

There are a number of ways by which this rejected heat may be utilized and of these I shall ask you to consider two.

First, by utilizing the rejected heat in the generation of steam for power purposes.

An engine designed with this object in view could be arranged so as to utilize practically all the heat lost to the jacket water and, by properly proportioning the heating surface of the steam generator, the greater part of the heat resident in the exhaust gases could also be withdrawn. Assuming that the steam is to be generated at a pressure of 100 pounds gage, the feed water being at a temperature of 185 degrees Fahr., it would require 1,100 British thermal units to generate one pound of steam. The temperature of saturated steam at the assumed pressure being 338 degrees Fahr., it would be practicable to reduce the temperature of the exhaust gases to, say, 550 degrees Fahr. We could, therefore, abstract sufficient heat from these gases to reduce their temperature by 1,150 degrees Fahr. Assuming the specific heat of these gases to remain constant over this range of temperature, which is practically the case, we can easily deduce that 68 per cent. of the heat contained in the products of combustion can be abstracted. The total amount of heat available, then, in an engine of 100 indicated horse-power would be, approximately, neglecting radiation losses, 338,000 plus 68 per cent. of 382,000, or 598,000 British thermal units per hour. Deducting 10 per cent. for radiation losses, we get as a net result 540,000 British thermal units per hour.

This amount of heat would, under the assumed conditions, generate steam at the rate of 490 pounds per hour. From this we can see that the indicated horse-power of a single 100 horse-power gas engine could be increased by about 10 to 12 per cent. This small gain in power would not be a proper return for the extra outlay and trouble involved. If, however, the plant were large enough to warrant the installation of a compound condensing engine, this increase in power might reach under favorable conditions as much as 30 or even 35 per cent. I believe that an installation of this sort would, for plants of 1,000 horse-power or over, prove to be economical in the generation of power, especially in localities where fuel is expensive. Since the steam engine, in this case, could not be governed in any of the usual ways, it would be necessary to connect it in some manner to one of the gas engine units. The best arrangement doubtless would be to have one or more of the gas engine units constructed as a steam gas engine, with the steam and gas cylinders arranged tandem, or at least connected to the same crank shaft. This would be a perfectly practicable arrangement, and should not be confounded with any of the various methods that have been tried, but without success, of introducing the steam into the gas engine cylinder.

Second, by utilizing the discarded heat for warming buildings, drying, cooking, etc. In shops, factories, office buildings, hotels, restaurants, laundries, etc., the waste heat from gas engines could be used in most instances to greater advantage than that from steam engines.

For general warming purposes I believe that a hot water system would, in most cases, be the best to install. It would possess the advantage of being applicable to gas engines as now built without necessitating any change in the engines proper, besides being safe convenient and economical. The arrangement that I have in mind is as follows: The main return from the hot water heating system is connected to the engine at or near the bottom of the water jacket. The top of the water jacket is connected directly to a heater, through which the exhaust from the engine is made to pass, the heater being connected to the main flow pipe of the hot water heating system.

The action would be as follows: The water from the main return of the heating system entering the engine jacket at say, 110 degrees Fahr., would leave at a temperature of, say, 135 degrees, carrying with it the heat ordinarily rejected to the water jacket. It would then enter the heater at a temperature of 135 degrees and leave at say 165 degrees, having reduced the temperature of the exhaust gases to say 300 degrees which would be practicable in a well-designed heater. This of course presupposes the rapid circulation that is so desirable in most hot water heating systems.

Assuming, as before, that the temperature of the exhaust gases is 1,700 degrees Fahr., it would be practicable to abstract enough heat to lower their temperature 1,700 degrees minus 300 degrees, or 1,400 degrees. Under favorable conditions, then, we could abstract 82 per cent. of the heat ordinarily rejected in the exhaust gases. The total amount of heat available for heating purposes then in an engine of 100 horse-power capacity running at full load, deducting 8 per cent. for radiation losses, would be at the rate of 600,000 British thermal units per hour.

From the reports of the U. S. Signal Service, it would appear that the mean temperature at Pittsburgh for the months of November, December, January, February and March, are respectively 40, 31, 29, 31 and 39 degrees, making an average, for the five coldest months, of 34 degrees Fahr.

Using the formula $h = (n\,C / 55 + G + W / 4)\,t$, in which C is the cubic contents of the room or building, W the area of exposed wall, G the area of glass, n the number of changes of air per hour, t the difference between inside and outside temperatures, and h the number of heat units required per hour; I get my substituting average values obtained from a recently constructed business block, the formula $C = 14\,h / t$.

The rejected heat from the 100 indicated horse power engine considered would then, while running under full load, maintain a temperature of 70 degrees within a building having a volume of $C = 14 \times 600{,}000/(70-34) = 233{,}000$ cubic feet, or a floor space of about 20,000 square feet, the temperature without being the mean obtained for the five coldest months at Pittsburgh. In an office building this same engine would furnish sufficient heat, under the above conditions, for 58 rooms, the rooms having an average volume of 4,000 cubic feet. For zero temperature outside, however, and 70 degrees within, the volume heated would be reduced to 120,000 cubic feet, or in the office building considered to 30 rooms, leaving 28 rooms to be heated from some other source. On the other hand, when the temperature rose above 34 degrees some of the rejected heat would have to go to waste.

If this same engine be placed in a building having a volume of 480,000 cubic feet, it would furnish enough heat to maintain a temperature of 70 degrees within, when the temperature without was 52 degrees; while for zero temperature it would furnish but one-fourth the heat required. It would then be necessary to place one or more additional heaters in circuit between the engine heater and the main flow pipe of the hot-water system. For the mean temperature at Pittsburgh, during the five coldest months, this engine would furnish a trifle over 50 per cent. of the heat necessary.

I am well aware of the fact that in buildings of the character considered, there is ordinarily, during the day, a demand for but

a small fraction of 100 horse-power. But the demand for this amount of power could be easily created through the business portions of our cities. What I refer to is the placing at convenient locations, in the basement of such buildings as could best utilize the discarded heat from gas engines, plants of from say 50 to 500 horse-power capacity, such plants to furnish power for the elevators, printing presses, etc., located within a convenient radius. For such service, with hydraulic transmission arranged with provision for a moderate storage, the load upon the engines could be kept practically constant during the business hours of the day.

This proposed method of utilizing the waste heat from gas engines would also be well adapted to shops, factories, laundries, in fact to any building in which both power and heat are required.

COST OF POWER.

The best modern gas engines of from 50 to 100 horse power, running at full load, will show a heat consumption, when using illuminating gas of average composition, of 10,000 British thermal units per indicated horse-power hour, or 11,500 per British horse power hour. If we take as average values for illuminating and natural gases, respectively, 675 and 1,000 British thermal units per cubic foot, we get the gas consumption per horse-power hour as follows: First, for illuminating gas per indicated horse-power hour, 14.8 cubic feet, and per brake horse-power hour, 17.0 cubic feet; second, for natural gas per indicated horse power hour, 10.0 cubic feet, and per brake horse-power hour, 11.5 cubic feet.

I have been informed by the Pittsburg representative of a leading gas engine builder, that from their experience it would appear that the indicated work obtained from the use of these two gases is not in proportion to their respective heating values; that, whereas the average heating value of natural gas is about 50 per cent. greater than of illuminating gas, the indicated work per cubic foot, as compared with that of illuminating gas, was found, in a number of instances, to be from 5 to 10 per cent. greater. I am inclined to believe that the heating values of the gases may not have been up to the average, or that the best proportion of gas to air was not used. However, in order to be upon perfectly safe ground, I have assumed as a basis for my estimates, instead of the 11.5 cubic feet obtained, 16 cubic feet of natural gas per brake horse-power hour.

My estimate for the cost of 100 brake horse-power for 309 days of 10 hours each, allowing the rejected heat to go to waste, is as follows:

Interest on cost of plant, $3,500 at 6 per cent	$210.00
Depreciation and repairs, at 7 per cent	245.00
4,944 thousand feet natural gas at 15 cents, net	741.60
Attendance, ¼ time at $2.50 per day	193.13
Supplies	120.00
Total cost of 100 brake horse-power per annum	$1,509.7

This is at the rate of $15.10 per brake horse-power per annum upon the supposition that the engine runs at full power for 309 days of 10 hours each.

Running upon the same service, but at one half load, assuming that the thermo-dynamic efficiency remains constant, which would be practically the case for an engine governed by the hit and miss method, and also assuming a mechanical efficiency of 87 per cent. I get as follows:

Interest on cost of plant, $3,509 at 6 per cent	$210.00
Depreciation and repairs at 6½ per cent	227.50
2,794 thousand feet natural gas at 15 cents, net	419.10
Attendance, one-quarter time at $2.50 per day	193.13
Supplies	100.00
Total cost of 50 brake horse power per annum	$1,149.73
Cost per brake horse-power per annum of 309 days of 10 hours	22.99

Running upon the same service, but at one-fourth load, the cost of 25 brake horse-power would be $38.43.

Assuming that this engine runs under a load that varies from 25 to 100 brake horse-power, so that the summations of the time intervals at intermediate points are practically equal, then the cost per brake horse-power per annum would be $25.51.

In these estimates no rental charge for space has been entered, because of the fact that an engine of 100 horse-power, of the vertical multiple cylinder type, would require a floor space of not more than 5 by 8 feet, and could be placed in the least valuable part of the basement.

No charge was entered for jacket water supply, because the jacket water could be cooled by being circulated through a tank, or cooling coils, located on the roof, or at other convenient place outside of the building. This could be accomplished, for average conditions, at an extra cost of about 45 cents per brake horse power per annum, which is of course, quite insignificant.

My estimates, then, for the cost of power, when generated by gas engine units of 100 brake horse-power, located in the basements of suitable business buildings of Pittsburgh and Allegheny, would be, for natural gas and upon the basis of 309 days of 10 hours, as follows:

1.	When running at full load	$15.55
2.	When running at one-half load	23.44
3.	When running at one-fourth load	38.88
4.	When running at from one-fourth to full load	25.96

Should the rejected heat be utilized for heating purposes, in the manner that has been proposed in this paper, no extra expense of consequence for installation need be incurred, since the cost of the apparatus necessary to abstract heat from the exhaust gases would be practically offset by the reduction in cost of the other heating apparatus.

I shall make no attempt in this paper, as to do so would make it unduly long, to estimate the value of the rejected heat when utilized in the various ways suggested. The amount of heat, however, that could be utilized for heating purposes, at practically no expense, may be deduced from what has been given, and would be as follows:

			British thermal units per hour.
1.	Engine of 100 brake horse power,	at full power	690,000
2.	" " " "	at one-half power	391,000
3.	" " " "	at one-fourth power	240,000
4.	" " " "	at one-fourth to full power	440,000

Using the formula derived for average conditions, namely, $G = 14h/t$, I get, by substituting the proper values given for Pittsburg, the following for the cubic foot of space that could be heated, when the temperature without is the average for the five coldest months:

			Cubic feet of space.
1.	Engine of 100 brake horse power,	at full power	269,000
2.	" " " "	at one-half power	152,000
3.	" " " "	at one-fourth power	94,000
4.	" " " "	at one-fourth to full power	172,000

Recent Arbitration Committee Decisions.

Last month we published in full one important recent decision of the M. C. B. Arbitration Committee, and in what follows we abstract several others of some importance:

Case No. 381, between the Pennsylvania Railroad and the Phil. & Reading, involves an allowance for scrap credits for parts of a car missing and broken and replaced by the latter road. The only credits it allowed were for such parts as were damaged, but not lost. The Pennsylvania claimed that the rules required scrap credits for missing parts and in this respect were just, for the missing parts must be in the possession of the road at some point along its line. In this claim it was sustained by the Arbitration Committee.

Case No. 383 is an unusual one, though it belongs to a class that should never come before the committee, as the right and wrong in the case is too evident to need a decision. The Texas Central road had a flat car that left its lines in 1889. After two years it was reported in such bad condition as to require general overhauling to get it home. Authority for this was not given, but in 1895 the C. O. & S. W. Ry. asks authority to repair it sufficiently to make it safe to send home. Authority is given, and under this authority rotten parts are replaced and a bill of $65.77 rendered. This the road refused to pay, but the Arbitration Committee decides that the bill is just.

Case No. 388 is between the Great Northern and the Duluth & Iron Range. The latter road has some new cars built, and these were delivered to them over the line of the Great Northern. One car had every wheel slid flat to such an extent as to be ruined. The Great Northern replaced them and rendered a bill, claiming that the pipe to the retaining valve was full of chips which prevented the brakes from properly releasing on a long grade. It had tested the brakes before the train started, and though the brakes then released, the Great Northern assumed that the operation was accidental. The committee held the Great Northern responsible because the defect in the brake would have been detected if its inspection had been thorough.

In the course of a few weeks it is expected that the Hardie compressed air motor will be in service on the Ninth avenue elevated line in New York City. The air compressing plant is complete, as is also the motor, and the conne[illegible]ons from the power-house to the charging point on the el[illegible] structure are being made.

Diagram for Determining the Lengths of Rivets.

The accompanying diagram for determining the length of rivets is in use in the Bureau of Steam Engineering of the Navy Department, and provides a means for promptly finding the length of rivets without calculation of any kind. The diagram is based on the assumption that all rivet holes are 1/16 of an inch larger than the rivets; that the riveting is done by machinery, and that the two heads of a rivet are alike and of the following dimensions:

Diameter of rivet.	Greatest diam. of head.	Least diam. of head.	Thickness of head.	Weight of ten heads.
Inches.	Inches.	Inches.	Inches.	Pounds.
7/16	13/16	3/8	7/16	.331
1/2	15/16	7/16	1/2	.531
9/16	1	1/2	9/16	.731
5/8	1 1/8	9/16	5/8	1.007
11/16	1 1/4	5/8	11/16	1.373
3/4	1 5/16	5/8	3/4	1.551
13/16	1 7/16	11/16	13/16	2.032
7/8	1 1/2	11/16	7/8	2.258
15/16	1 5/8	3/4	15/16	2.871
1	1 3/4	13/16	1	3.584
1 1/16	1 13/16	13/16	1 1/16	3.910
1 1/8	1 15/16	7/8	1 1/8	4.761
1 3/16	2	7/8	1 3/16	5.170
1 1/4	2 1/8	15/16	1 1/4	6.215
1 5/16	2 1/4	1	1 5/16	7.391

Our reproduction of the diagram is exactly one-half scale and if our readers will imagine it to be full size the method of using it is this: Apply a common rule to the diagram along the horizontal line which corresponds to the diameter of the rivet under consideration and read off the distance in inches from the line A B to that line which indicates the sum of the thickness of the plates through which the rivet is to pass; the result will be the correct length of the rivet measured from under the head. As an example assume that a 1⅛-inch rivet is to be used and the plates sum up to the thickness of 2⅝ inches; look for 1⅛ on the line A B and measure from it to the point where the horizontal intersects the curve marked 2⅝. The distance (on the full size diagram) is 5 1/16 inches, which is the correct length under the head.

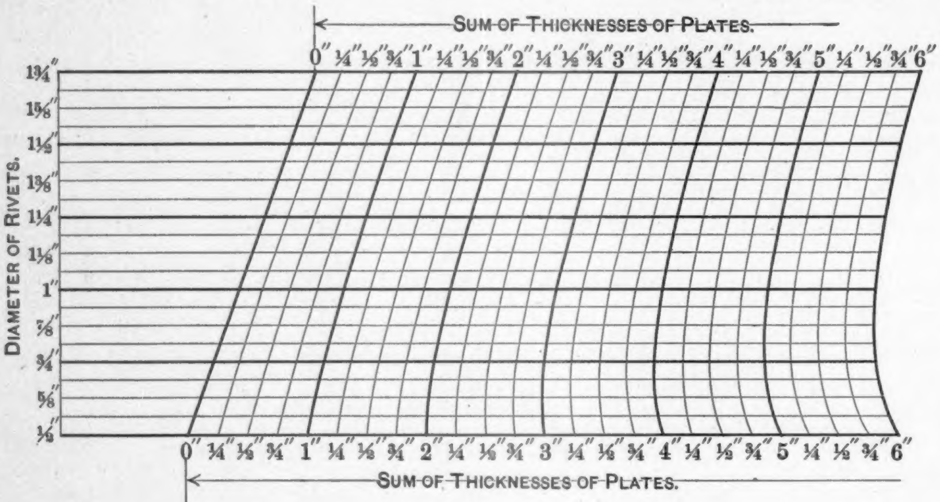


Diagram for Determining the Length of Rivets.

This is one of those handy diagrams which every engineer and designer appreciates for the saving of time arising through its use. Those desiring to make one for themselves can just double the size of our engraving, vertically and horizontally, and the scale will then be full size so that the sizes can be read off with a common rule.

The Canadian Manufacturer, published at Toronto, Canada will publish a special edition containing the new Canadian tariff the new United State tariff, the British tariff and the British Merchandise Act. ecial edition will appear as soon as the new tariff becom

Elasticity and Fatigue.

H. K. LANDIS, E. M.

PART I.—ELASTICITY.

The primary consideration in investigating the quality of structural material is that combination of properties which will render behavior in service a constant factor. This is especially true of all high-requirement material, such as iron and steel, particularly the latter. The principal factor upon which the invariability of steel depends is the property known as elasticity, for while retaining its elasticity the ability of steel to resist stresses externally applied is very great. When, however, the stresses are of such nature or magnitude as to destroy the elastic properties of the material, fatigue results, and the material succumbs after a comparatively short time in service. It is therefore of primary importance that we understand the factors which produce, influence or destroy this elastic condition of steel, and especially those influences which tend to cause failure of the material through fatigue.

Elasticity.—The celebrated physicist Sir William Thompson defined this term as "that property in virtue of which a body requires force to change its bulk or shape, requires a continued application of the force to maintain the change, and which springs back when the force is removed." Perfect elasticity can exist only in isotropic bodies; such bodies are homogeneous solids which are uniform in composition, equally elastic in any direction, and conduct heat and electricity, or radiate heat and light with equal facility in all directions. Evidently steel is not an isotropic body; M. Mercadier has shown this conclusively in his very interesting experiments indicating that steel lacks physical homogeneity, and that "elasticity can vary much in the direction of certain radii." In criticising the statements of M. Hartmann that "metals acts like homogeneous bodies" M. Georges Charpy says: "Chemical action shows, after as before deformation, that there are constituents which are attacked unequally, and according to results obtained, which are also unequally deformable." It therefore follows, as steel is subject to segregation, local irregularities and other defects due not only to its handling, but also to the nature of the material, that steel is not isotropic and consequently *not perfectly elastic.* This is a fact which must not be lost sight of, for it explains several puzzling phenomena, and has caused Mr. Burr to remark that "some experimenters . . . have been led to believe that a very small permanent 'set' exists with any degree of stress whatever," and therefore that incipient failure begins from the moment any load, however small, is applied. Such generalizations are dangerous and misleading, so we will be contented with the statement that steel is not isotropic and therefore cannot be perfectly elastic. We may also take the liberty to modify Sir William Thompson's definition, and say that a body is perfectly elastic when it returns to its *initial condition* after change of form by an external force.

Granting that steel lacks the property of being perfectly elastic, and that this imperfection exists in varying degrees, we may ask in legal parlance, "If so, why so?" Iron unites with metallic alloys such as nickel, manganese, chromium, etc., in all proportions; it combines with carbon in quantity up to probably four per cent., though commercial steels usually contain from 0.09 to 0.5 per cent. of carbon. When a very large ingot of steel is left to cool slowly, there is a tendency for the foreign components to go off by themselves, to segregate and separate from the congealing iron, just as ice excludes impurities in water

while being frozen, and thus forming local and regional segregations, which vary considerably in composition from the remainder of the steel ingot. Nickel, sulphur, phosphorus, slag and carbon to a less degree are thus liable to collect, forming plates or bars which vary considerably in chemical composition, and consequently in elongation and elastic properties; per cent. elongation may vary two points for every .0105 per cent. carbon, while the elastic limit may vary 1,000 pounds per square inch for each 0.01 per cent. carbon. As the nickel, when alloyed in quantities of 3 per cent., may increase the elastic limit 15 per cent., and a 5 per cent. nickel alloy by 50 per cent., we see how the other impurities may, by their unequal distribution, give adjacent particles entirely different elastic qualities. The presence of blowholes, hollow pipes and lamination due to internal fractures or cold working are often hard to detect, and are the most glaring of irregularities. Residual internal stresses due to forging at too low a temperature, cold working, unequal cooling, etc., are, unfortunately, little known, and are some of the most fruitful sources of fatigue, and the most insidious of the destroyers of elasticity. Again there are such local partial deformations as "gag marks" in straightening beams, rails or rods, hammer marks, the effects of punching, shearing, stamping, etc., all of which form a good start for the progressive breaking down of the material. The specific gravity or density also is changed by handling and treatment. M. Caron by 30 successive heating and quenching operations reduced the density of steel from 7.817 to 7.743. Mr. Horace Allen changed the density of a mild steel billet, by rolling into a rod, from 7.826 to 7.865, and then back to 7.852 by subsequent annealing; this rod was drawn into No. 10 B. W. G. wire which had a specific gravity of 7.815, or after annealing 7.824. Cold rolling also increases the density; according to Mr. Lanza it also increases the limit of elasticity 80 to 125 per cent., although it would be interesting to know how he determined this limit, for by the usual tests there is no very decided jog in the stress-stretch curve with cold-rolled or cold-drawn unannealed rods or tubing.

It therefore becomes very evident that when any or all of the aforesaid influences have been at work on steel, its degree of elasticity will depend upon the extent of these influences. The determination and evolution of such destructive factors is by present methods impracticable, except as they occur in such a manner as to be shown in ordinary testing. Ordinary masses of steel are quite constant in chemical and physical composition, though the same cannot be said of internal stresses present in nearly all steels. Material which has been bent cold has four zones of alternating tension and compression; rolled rods cool more quickly on the exterior and have, when cold, the exterior in compression and the interior in tension. Rodman cast-iron guns have 10,000 pounds per square inch compression on their internal bore and 4,000 pounds per square inch tension on the outside purposely secured by cooling the interior and heating the exterior after casting; ordinary forged material will have stresses from 1,000 to 10,000 pounds per square inch initial stresses, which usually cannot be determined without destroying the material; imagine the body of a material you are about to test to be filled with conflicting tensile and compressive stresses, whose magnitude you have no means of knowing, and then follow their action as a piece of steel is slowly pulled apart—why, even the turning of a test specimen creates initial stresses, rough turning putting the surface in probably 2,000 pounds' tension, while a small cut with a dull tool will put it in compression and raise the unit tensile strength by several thousand pounds. These are facts known to well-informed testing engineers. Under the influence of such stresses some particles may even be stressed beyond their elastic limit and form permanent sets before others are out of compression and then we will have progressive destruction from the start; this is what happens with cold-rolled or cold-drawn steel in varying degrees; for not only tensile but also endurance tests show that though such material in the unannealed state has a high tensile strength, yet it has no well-defined limit of elasticity. Such considerations are doubtless what led that careful engineer James Christie to say that "The elasticity of either steel or iron is so variable and uncertain that it is difficult to assign a definite value to any particular material except by taking the average of numerous experiments." Generally speaking steel is said to be elastic while the ratio of the successive loads per square inch of cross-section divided by the resulting stretch in decimals of an inch per inch in length remains a constant factor; for a steel which stretches 0.0003 inch for each 1,000 pounds per square inch load applied this factor would be $33\frac{1}{3}$ million.

Elastic Factors.—Let us now look at the various terms used in defining elasticity in steel and the methods used in determining them. In the testing of steel, as the stresses increase from zero we pass successively through the elastic conditions determined by the coefficient of elasticity, through the several limits as determined by our various authorities, and which often vary as much as 10,000 pounds per square inch, into the condition of progressive destructive, and end with fracture of the material at the tensile strength or breaking load. We will arrange them as follows:

1. Dynamic coefficient for modulus of elasticity (Ed.).
2. Static " " " " (E.).
3. Limit of proportionality (L. P.).
4. Elastic limit (yield point, 1st permanent "set") (E. L.).
5. Elastic limit (drop of beam).
6. Ultimate tensile strength (breaking load) (T. S.).

Methods of Testing Elasticity.—In order to still more fully understand what is meant by elasticity in the commercial and scientific world, a condensed description of the methods in use will be necessary. There are two classes of machines in general operation—the lever machines, such as are used in the smaller works and laboratories and in colleges, and the few more complicated machines of which the Emery is a type. The former has power supplied to it by either screws operated by hand or from a line shaft and belt, or by a hydraulic cylinder using oil supplied by a duplex pressure pump. These sources of tension are attached to one end of the bar to be tested by means of movable jaws or clamps; the other end of the bar is fastened by similar wedges or jaws to a plate bearing on a series of double compound levers which terminate in a long scale beam, over the graduations of which a weight is made to roll under control of the operator. When, therefore, the power of the screw or hydraulic pressure causes tension in the test rod, this tension is transmitted at the other end through the series of levers to the scale beam, where it is measured in pounds by moving the weight along until the beam is balanced and vibrates freely; this load, divided by the area of cross-section of the test piece in square inches, will be the unit stress in pounds per square inch when square inches and pounds are used. Tons (2,240 pounds) per square inch are used in England, while kilograms per square millimeter are used on the Continent (1 kilogram per square millimeter equals 1,422.3 pounds per square inch). In some cases the tension is measured, not by levers, but by a pressure gage, a mercury manometer or other methods, and this is especially the case with machines for testing full-sized members such as eye bars for bridges. The Emery machines are more accurate throughout, are of greater capacity, are very sensitive and easily controlled. Hydraulic power is supplied by oil pumps and the tension measured by adding small weights successively to a scale beam until a balance beam or index indicates equilibrium; any fluctuations in this beam indicate breaks in the constant ratio of stress to stretch, and consequently in elasticity. Elongation is usually measured by a scaled arc extensometer or electric micrometer, sometimes by a fine micrometer screw. As far as the writer is aware, the "mirror apparatus" described by Mr. Henning (American Machinist, Feb. 11, 1895) is not in general use on any of the larger machines of this class; the same may be said of similar apparatus used on the Continent by Wedding, Martens, Rudloff and other investigators. As elasticity is reckoned in terms of elongation, it is apparent that the accuracy of the elongation determination establishes at once the accuracy of the elasticity determination. Stretch is gotten by various methods, nearly all of which depend somewhat on human judgment, never at best infallible, and so we may expect to find some startling results. When investigating this subject Mr. Webster sent samples of the same steel from the same bar to seven differ-

ent works and laboratories, and received the following determinations of elastic limit: 37,200, 37,350, 37,490, 38,900, 39,090, 39,700 42,400. This was on a 0.19 per cent. carbon steel by presumably the same method. He further says: " By the present methods in use no reliance whatever can be placed on the elastic limits reported," and says he knows of cases in which the test piece had stretched three-tenths of an inch beyond the yield point before the elastic limit was taken. This condition of affairs as stated seems somewhat abnormal, so let us look at the method employed in the ordinary lever machines in use.

Drop of Beam.—The test specimen is prepared in various ways. Bessemer heat tests are rolled into flat bars and center-punch marks made on them 8 or 10 inches apart, the width and thickness recorded, bar placed in the jaws of the testing machine, the driving belt thrown in or steam turned on the pump, and then the operator moves the weight along the balance beam in such a manner that it vibrates freely about the middle of its range, until a load is reached where it suddenly drops, and a few moments elapse before it gradually regains its middle position again; this load is the elastic limit determined by "drop of beam." We here see that it is assumed that the rate of application of load is uniform, as it is, approximately; that the rate of stretch is proportional to the rate at which the load is applied, as it is, approximately; therefore, that when the rate of stretch suddenly increases, the rate of loading being constant, the weight must be moved more slowly; consequently the limit of elasticity must lie somewhere near the point where the rate of stretch changes, as it does—approximately—very approximately. Now, how will we account for the drop of the beam? It is well known by those who have tested much material that where steel is slowly stretched until broken that the rate of elongation of small parts of the length is not always the same for each; first one division will stretch, then make a stubborn stand, then another and still another, showing local weakness, until the middle divisions elongate and the piece breaks. This takes place with all stresses, and makes the elastic curve quite irregular. Howe and Kreuzpointner have shown that the stretch of each division is not proportional to its distance from the break, but that they are quite irregular. We can then say that partial failure and recovery is a property of stretched steel, and that this stubborn resistance before the material jumps to its next place to hold on may prolong the unit resistance beyond the point where a proportional elongation would place it. The drop of the beam is evidently caused by such a jump and recovery; therefore, according to the preceding explanation, we can say that this point is too high, and such, in fact, is the case, as shown by a number of engineers who have carefully investigated the subject. More exact methods are employed where the limit of elasticity is defined as the point of first permanent set. Formerly but a single center-punch mark was made on a test piece, one leg of a dividers spaced 8 inches placed in it and a mark scratched with the other on a chalked surface near the other end, at a distance of 8 inches; then loads were applied until somewhere near the elastic limit suspected, and another scratch made on the chalk. Then unit loads of about a 1,000 pounds, successively applied until the scratches or scribe-marks predicted a sudden increase in the stretch, when but 500 pounds were applied until there was undoubtedly a suddenly increase in elongation. This was the elastic limit and was corroborated by the cracking of scale on the specimen, the extra number of turns of the screw or strokes of the pump to produce the load, and the drop of the beam. This gave closer results than simply the drop of the beam. Permanent "set" methods succeeded, for it was found quite difficult to determine accurately the differences of 0.0003 of an inch for each load applied on a chalked surface full of lines previously made.

Permanent Set.—A set takes place when the material does not return to its original length, and, according to Sir W. Thompson, there its elasticity ends. Therefore, after stretching the test piece to near the elastic limit, the load was entirely released and the distance between two punch marks measured. If no change was evident with the micrometer used another unit load was applied, decreasing from 4,000 to 2,000, 1,000 and 500 pounds, and the same measurements taken as before, until a decided increase in the amount of stretch is noted, usually not more than 0.0001 inch per 1,000 pounds in 8 inches. By fastening an electric contact micrometer to the test specimen at both punch marks, a bell rings when the specimen returns to its original position and ceases to ring when it does not. A micrometer screw then determines the amount of "set."

Proportionality.—There is another point which is not usually determined in our laboratories, although it is quite common in France and Germany, and is known as the limit of proportionality. We have seen before that the " drop of beam" depended on the assumption that it had *something* to do with elasticity; that may or may not be so, but we *are* certain that it has something to do with failure, and is the palpable evidence of progressive destruction. We have also seen it claimed that the first permanent " set" had some intimate or remote relations with elasticity; that may or may not be true again, but we *do* know that it is the first evidence we have of actual deformation. Let us then examine into what we know to be an undoubted factor of elasticity.

The modulus of elasticity, formerly called the coefficient of elasticity, is the ratio of the unit load to the unit stretch which it produces. If each increment of load of 2,000 pounds per square inch produced an increment in stretch of 0.00008 of an inch per inch of length there would result a modulus of elasticity of 25 million. This ratio between stress and stretch is a property of elasticity which remains approximately constant in very homogeneous steels, though in many the rate of stretch gradually increases from the beginning, and in others some of the successive elongations vary considerably, apparently by successive jumps; thus we are again reminded that steel is not isotropic. With the electric contact micrometer, the successive elongations are measured after each corresponding load increment, by turning the micrometer screw until the electric bell rings, and reading it, which can be done readily to 1-10000 of an inch. The error of micrometer screws are sometimes considerable, so that a reflecting extensometer such as described by Mr. Henning is quicker and more accurate for such small readings. To describe the latter briefly, the test piece being marked on opposite sides near each end, the base is clamped to the lower marks; from the base rise two springs on either side of the specimen which terminate at the upper mark in two rollers carrying on their extended horizontal axes two mirrors; these small mirrors are adjusted in such a manner that a telescope directed to them at a distance of 5 feet will see the reflection of the zero point on two vertical scales beside the telescope. If now the piece is slightly elongated the rollers in contact with it will revolve, and with them the two mirrors, thus bringing another reading of the reflected scale within the field of the telescope. Thus the actual elongation is magnified to a much greater extent than it would have been with any micrometer screw, eliminating the appreciable errors of thread and graduation, and enabling one to determine exceedingly small changes in stretch.

While the modulus of elasticity is constant the proportionality of unit stress to a unit stretch is also constant; as soon as the next increment of load produces a greater increment of elongation, proportionality ceases, and we have what is called the limit of proportionality. This limit is located at the point where, according to the French commission of tests, an additional 1,000 pounds per square inch load will produce an increase in increment of elongation in 8 inches of 0.000027 of an inch; as the error of a screw micrometer is probably twice this amount, the necessity of improved apparatus is apparent. The Engineering News (July 25, 1895, page 60) suggests the placing of this limit of elasticity at the point where the next elongation will be three or four times what it was between total unit loads of 4,000 to 24,000 pounds. We notice that the limit of proportionality has nothing to do with drop of beam or permanent set; it is a factor of elasticity and not of deformation; it is as much a refinement on the yield point as the yield point was on the drop of beam. So that here we have three distinct limits of elasticity, each with its supporters among our best engineers and metallurgists; we have both a dynamic (as

yet experimental) and a static coefficient of elasticity; add to these the promiscuous manner in which bent, tempered, annealed, cold and hot-worked, uniform and segregated material of known and unknown composition are reported, and then try to guess what a man means when he tells you the steel of a certain lot of rails had an elastic limit of 40,000 pounds; and, therefore, in his opinion, were strong enough.

Comparison of Limits.—To give an approximate idea as to the relative location of the various limits, we can say, and with some basis of accuracy, that the drop of the beam lies (the difference increasing as the carbon decreases) 1,000 to 5,000 pounds per square inch above the yield point; that the elastic limit or yield point lies from 2,000 to 10,000 pounds per square inch above the limit of proportionality, and that the location of the limit of proportionality depends largely upon the delicacy of the apparatus employed and the mechanical condition of the steel. The error of the usual lever machine due to friction, inertia, etc., is about 6 per cent., rising as high as 15 per cent., according to Mr. Henning, when the bearing surfaces are in bad condition. The usual method, in fact, with structural material, almost the only method in daily use, is to determine elasticity by the drop of the beam. Suppose the steel rail having the elastic limit of 40,000 pounds per square inch were inquired into. The error of machine correction of +.06 would bring it up to 42,400 drop of beam E. L. Let us take the yield point at 40,400, i. e., 2,000 pounds lower, and the limit of proportionality 4,000 pounds lower still, at 36,400, which is an error of 8 per cent. and brings the limit of elasticity near the point of rejection of the material. It is, therefore, scarcely necessary to remind engineers that a limit should be included in their specifications which will correspond to each of the three methods of testing. It would also be well to have two series of tests: 1st, a *quality test*, in which all specimens are to be tested in tension in the usual manner *after being annealed* at a stated temperature for a stated time; 2d, a *condition test*, in which the beam is tested for endurance, internal stresses, etc., in a manner which shall be as near a reproduction as possible of the actual service for which it is intended.

All of which goes to show that the usual elastic limit as reported tells us nothing about elasticity unless accompanied by full details. The E. L. as usually reported is therefore very much like the Illinois lawyer who "wiggled-wiggled in, and he wiggled out, and left the jury still in doubt as to whether the snake that made the track was going north or coming back."

What are we going to do about it? Nothing! As long as engineers and purchasers are willing to accept errors of 15 per cent. due to method of testing alone, the laity can have their private opinion, but things will go on as before, notwithstanding.

Dynamic Elasticity.—Referring to the dynamic coefficient of elasticity, and the dynamic method for determining isotropy, it might be said that it is something to think over very carefully. Lagrange first established the equation of equilibrium of elastic metal plates; Poisson applied his general theory of elastic forces to the same and found the conditions of vibration. Kirchhoff (*Comptes Rendus*, 1848–49) produced the equations of equilibrium and movement in an elastic plate. E. Mercadier took up these investigations (*ibid.*, 1884-85-87-88-89-91-92-93) and applied the principles in connection with his own equations to the investigation of circular and rectangular plates in determining the comparative degree of isotropy and elasticity in glass, iron, hard and mild steel, and nickel-steel; the results achieved compared very closely with tests made at the Creusot laboratories. Briefly, his method consists in taking a plate of steel whose thickness has been accurately determined, also its length or its diameter, supporting the plate freely at its nodal lines (a concentric circle whose radius is 0.68 the radius of the disc, or two transverse lines at a distance of 0.22 the length from both ends of the rectangular plate) on two straight edges or on one or three posts, all of cork. The procedure is, with discs, to support the disc on a single point at its center, strike the edge with a cork hammer and note the tone on the musical scale which results; then place the nodal circle on the three cork supports and strike on its center, noting the tone as before; the first tone will be the fundamental, the second the first harmonic of the disc; with rectangular plates the fundamental tone is determined by an electric contact recording chronograph which gives the number of vibrations direct, while in the former case the number of vibrations are found from the tones produced. This is the extent of the practical determinations. The data thus obtained is substituted in the appropriate formulæ and the comparative isotropy of steels examined; the coefficients of elasticity obtained differed but little from those determined in tension, being usually higher. Assuming that the ability to vibrate freely is a function of elasticity, we thus arrive at some interesting results. Mercadier suggests that steels be examined for their nodal lines and says that when sand is scattered evenly on a disc supported at its center, and struck on the edge, that the resulting vibrations will cause the sand to form a characteristic nodal line, and that "to a perfect homogeneity should correspond a perfectly circular nodal line"; he also says that this rarely happens by reason of a "lack of elastic symmetry," though these irregular nodes become more nearly circular as the plate becomes thicker; the sound, also, was found to be more confused as the elasticity became more distorted, and we are reminded how fatigued boiler plates and car wheels are often detected simply by the sound given when struck by a hammer. In connection with the work of Mercadier, those interested will find the investigations of Lamé, Saint-Venant, Wertheim and Chladin quite valuable. We find here a curious relation between this dynamic coefficient and the coefficient due to a static load; it is generally greater by several per cent., which indicates that but a portion of the metal in a tensile specimen resists elongation with its normal ability. Kreuzpointner has shown (Eng. Mag., March) that steel under tension has a tendency to flow. First the interior flows toward the middle, then the surface begins to stretch at the middle length and flows faster than interior, indicating a variation in physical condition of the surface and interior. We may say that this is due to surface work, to internal stresses, to "surface tension," to the property of flow, etc., but we cannot say that it represents actual conditions of the metal in a larger mass. The unit loads are calculated from the original diameter, consequently as the bar stretches, and its diameter and density become less its unit load will no longer be that on the original cross-section. Therefore, the successive increments of load reported are too small; it may even be that the dynamic coefficient obtained from the number of musical vibrations per second is the more nearly correct of the two. The difference was found to be in low carbon steel about five per cent.; in high carbon steel very slight; five per cent. nickel-steel, low carbon, a difference of 14 per cent.; 25 per cent. nickel high carbon steel gave a difference of 55 per cent.; the static coefficient seemed low in each case.

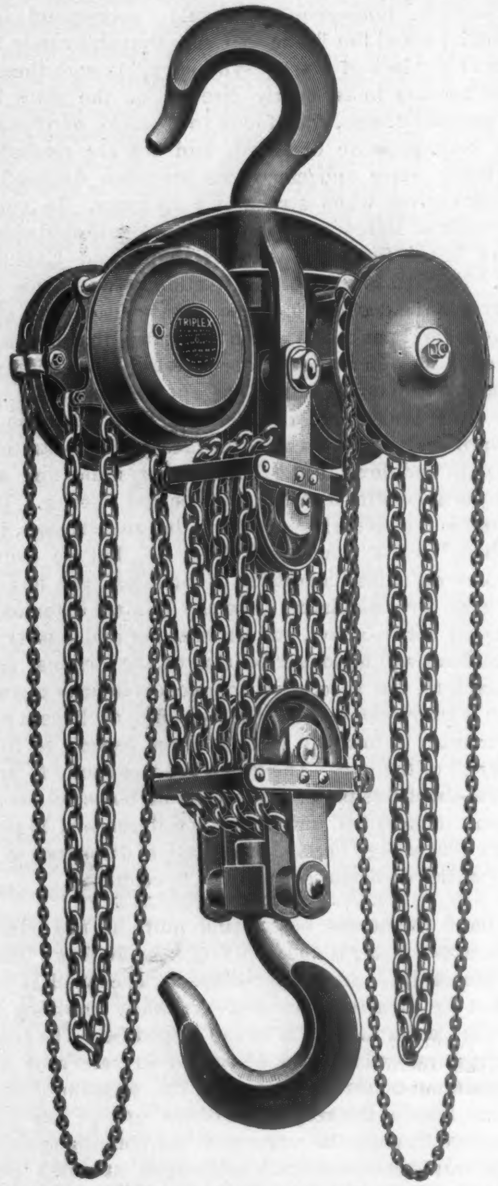
The Holland submarine boat being built at the Nixon shipyards, Elizabeth, N. J., is about 50 feet long, 10 feet 3 inches in diameter amidships, and is cigar-shaped. The shell is of half-inch steel at the greatest diameter, gradually thinning toward the ends. It carries three Whitehead torpedoes. The fuel is to be oil, and compressed air is to be stored in reservoirs at 3,000 pounds pressure for use in operating the torpedoes, expelling water ballast and for the respiration of the crew. The vessel is meant to move through the water with the conning tower above the surface, but it can be entirely submerged, at which time the motive power will be electricity, furnished by a storage battery.

That portion of the Illinois Central Railroad on which it is possible that electricity may be employed as a motive power extends from Randolph street to Sixty-third street, in Chicago, and is about eight miles long. There are thirteen stations in this distance, and the suburban service is undoubtedly the heaviest conducted by any surface steam railroad in this country. The Board of Directors of the railroad have authorized the President to continue his investigations into the expediency of electric motive power, and Mr. Wallace, Chief Engineer of the company, is at work on the problem. It is not expected, however, that the Illinois Central officials are going to make the transformation with the rapidity stated by some of our electrical contemporaries.

The Yale-Weston "Triplex" Chain Pulley Block.

When the Triplex chain block was first introduced a report was published of tests made by Prof. R. H. Thurston, of Cornell University, to determine the relative "mechanical efficiency" of the various types of chain blocks in use, which disclosed the remarkable fact that while the efficiency of seven other types ranged from 18.9 per cent. to 32 per cent. (the Weston differential block being one of the highest) the Triplex spur-geared block developed an efficiency of 79.5 per cent., or nearly threefold the average of other blocks. This result, since confirmed by experience, makes the Triplex block greatly more economical in use than any other wherever the use is frequent and economy of time or labor is material.

In order to meet the demand for blocks of large capacity and high efficiency, two new sizes of the Triplex block have recently been produced by Yale the & Towne Manufacturing Company, capable



The Yale-Weston "Triplex" Chain Pulley Block of 16 and 20 Tons Capacity.

respectively of handling loads of 16 and 20 tons. The accompanying illustration shows the design of these blocks. The construction consists in placing a yoke on the upper hook, each end of this yoke carrying a Triplex mechanism of two tons capacity and each mechanism being operated by an independent hand chain. The two slack ends of the hoisting chain are attached respectively to the two Triplex hoists. The first loop of this chain then passes around the driving sheave in each hoist and thence over two sets of intermediate sheaves, one set carried in the frame of the bottom hook and the other set in the frame connected directly with the shank of the upper hook. The number of parts of chain is such that the maximum load on each part does not exceed 2 tons. In like manner the maximum load on each hoist is limited to 2 tons, and this is the limit of load carried by each arm of the yoke. All the remainder of the load is suspended directly from the shank of the upper hook—a most admirable arrangement. This construction admits of greater compactness and occupies less headroom than any heretofore devised. Still greater compactness and from 18 to 20 inches additional headroom can be obtained by omitting the upper hook and crosshead and building the block into the trolley of a hand crane or overhead tramrail system.

A most important advantage arises from the fact that either or both of the two hoists may be operated simultaneously or independently. The full load may be raised by two men pulling together on the hand chain of one hoist, or at double speed by four men, two on each hoist. In like manner lowering may be effected at varying speeds by using either or both of the hoists. The location of the hoists at the outer ends of the yoke brings the two hand chains somewhat clear of the load and in the most convenient position for effective use.

This ingenious application of the Triplex system adapts it to the largest loads for which portable hoists are usually required, and by reason of the duplication of the hoisting mechanism enables the full power of four men to be utilized either in lifting the maximum load at normal speed, or lighter loads at great speed, whereas all other large hoists have heretofore had but a single hand chain, on which it is not possible to utilize effectively the power of more than two or at the most three men.

Capacity.	Hoist in feet.	Approximate weight.	Minimum distance from top to bottom hook.	Speed of hoist with four men.
16 tons........	12	1,000 pounds	5 feet 1 inch	0.50 feet per minute
20 tons........	12	1,150 pounds	6 feet 5 inches	0.39 feet per minute

The above table gives useful information concerning the hoists. Further information is obtainable from the Yale & Towne Manufacturing Company, Stamford, Conn.

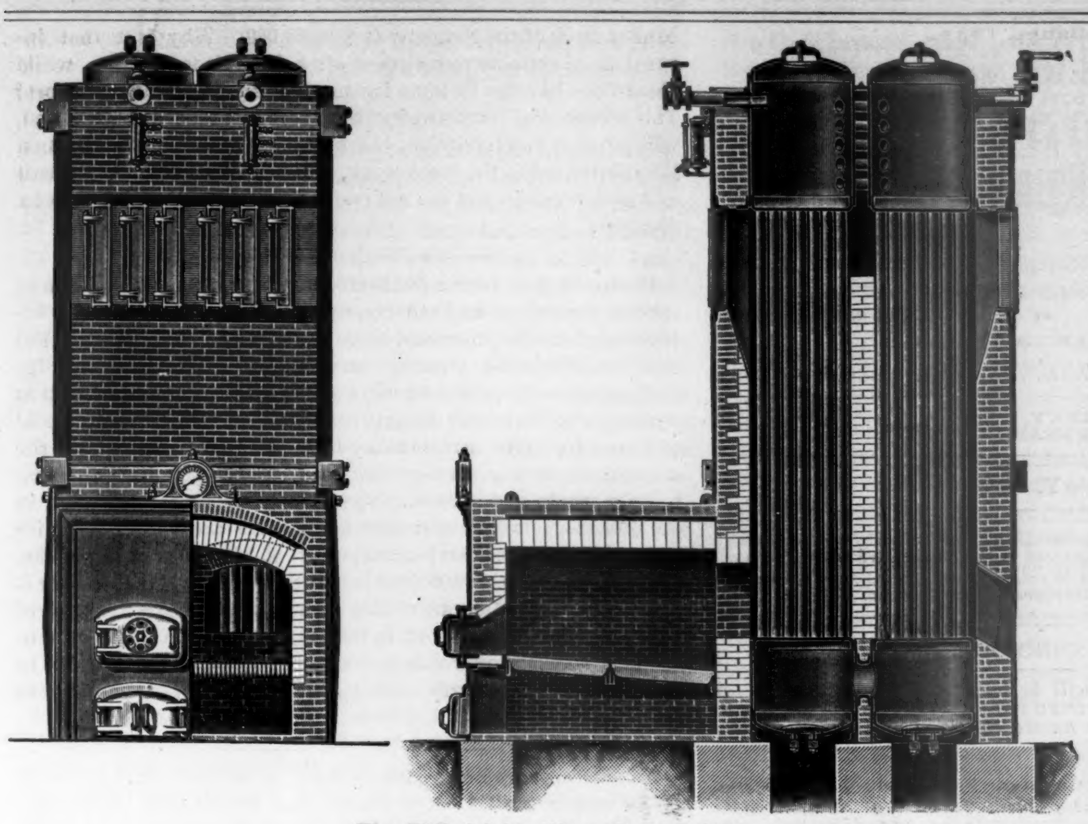
The Philadelphia Water-Tube Safety Boiler.

We show herewith a water-tube boiler built by the Philadelphia Engineering Works, Philadelphia, Pa., in which there are a number of features worthy of attention. In a single setting (the smallest type of complete boiler) there are two steam and two mud drums, joined by straight vertical tubes. The steam drum and mud drum, with their connecting tubes next the furnace, is termed the front set, and those toward the chimney the rear set. Each of these sets are surrounded by walls, forming two square chambers. The combustion chamber is external to these walls, and the gases from it pass through brick arches up the first set, over the center wall, and down the rear set to the chimney.

Connecting tubes join the two steam drums and the two mud drums, providing ample area for the strongest circulation possible, and for the equalization of the steam pressure under all conditions. The vertical tubes are set in rows, extending from front to rear, the space between these rows being greater than the outside diameter of the tubes. Opposite each space in the front and rear walls, openings, closed with doors, are provided to steam-sweep the tubes, and through which tubes may be passed when replacing is required. No doors are provided or required in the side walls, nor wasteful spaces between batteries allowed. A setting may therefore be built with its side walls against any wall or partition, and double, treble or any multiple setting is built with common dividing walls, as in return tubular practice. Much space is thus saved, and the outside radiating surface reduced.

No castings are subjected to heat and steam pressure. The domes are circular, and made of the best steel plate, of ample thickness. The heads are crowned to a radius of the diameter of the drums. The tube heads are especially thick and well stayed where not sustained by the tubes. The walls have heavy angle bars at each corner, held firmly by through bolts. In multiple settings these angles are replaced by tees at each dividing wall. A heavy ornamental front, with fire and ash-hole doors, faces the combustion chamber. This is stayed to the brick wall by horizontal angle bars, from which is sprung the double arch cover of the combustion chamber. A full complement of fittings of ample size and best construction is provided.

For this boiler practically perfect combustion is claimed, the combustion being complete before the gases come in contact



The Philadelphia Water-Tube Boiler.

with the heating surfaces. A strong circulation and the production of dry steam are other claims that seem fully warranted by the form of construction employed. The water level is preferably one-fourth way up the steam drum. The most heat is received by the front set of tubes expanding that column of water more than the column in the rear set, and circulation is commenced almost with the starting of the fire. Steam will be formed in the front set first, thus increasing the circulation. The feed water is introduced into the rear steam drum, and mingling with the water forms part of the downward current and assists the circulation. Before reaching the rear mud drum it has attained the full temperature of the water and precipitates its mineral impurities, depositing them in that drum, from which they may be blown out or removed. This drum is so situated that it receives no heat from the furnace. The purified water passes into the front drum and up the first set of tubes. The front set of tubes are then internally clean and full of water unmixed with steam when first presented to the action of the flame. Thus in this boiler the products of a practically complete combustion pass from the furnace and at their highest temperature pass among the tubes just above the mud drum, where these tubes are supplied with water unmixed with steam. In this condition they will absorb the maximum of heat with the least elevation of temperature, injury or deterioration. They absorb heat and keep cool, which is getting heat into the water while maintaining themselves. The gases then rise among the first set and pass down the second set, enveloping all tubes alike. There is no passage of least resistance, no selection of route and no short-cutting.

The company makes two styles of this boiler, the standard and the low boiler. They advocate the standard, but as the gases have to travel double the length of a tube vertically and the diameter of two drums hortizontally, the tubes may be much shorter than common without reducing the gas travel below good practice. Consequently where head room is limited they are prepared to build a shorter boiler. Their standard style is advocated, however, as the cost is less for a given heating surface. This standard style is not excessively high, the extreme height for a 260 horse-power boiler being only 22 feet; for a 60 horse-power boiler it is only 17 feet 7 inches.

Western Railway Charity.

There was brought to our attention recently a case which goes far to disprove the popular calumny to the effect that railroad corporations are "soulless." A farmer living in the Yakima Valley, this State, found it necessary to go to Chicago to have a surgical operation performed. He was very poor and could not pay fare, nor had he any property upon which to raise a dollar. His friends in Chicago succeeded in making arrangements for him at the hospital, but they could not bear the additional expense of his long journey across the continent. He presented these facts to the head offiec of the Northern Pacific Railway at St. Paul. The application for a pass was forwarded to the Tacoma office, and from thence to the agent of the local station in the Yakima Valley. The agent investigated the case, reported favorably, and the officials at St. Paul promptly forwarded the pass, together with a friendly letter to the unfortunate ranchman.

Now, this Yakima farmer is poor and obscure. He is not a member of the legislature, nor is he on intimate terms with any member of the legislature. He is not, nor is he likely to become, an important patron of the freight department of the road. The issuance of a pass to him could not be expected to add to the wealth or power of the Northern Pacific corporation, and the motive cannot be ascribed to any other influence than the natural impulse of a gentleman of the real sort. There may be "soulless" corporations, but the Northern Pacific is not one of them. Naturally, the farmer was grateful, and, being grateful, he chanced to converse upon the subject with a newspaper representative. No doubt there are many similar cases which have never seen the light of publicity. We should like the members of our Populist legislature to read this little narrative, which is strictly true in every particular.—*Spokane (Wash) Outburst.*

A Market for Oak Lumber.

Stephen H. Angell, United States Consul at Roubaix, France, says, in a recent consular report, that there exists in the northern part of France a demand for oak lumber, which is largely supplied from the forests of Hungary, and his attention has been called to the fact by dealers in oak lumber that American forests supply a quality of oak which, though said to be slightly inferior to Hungarian oak, could, nevertheless, in a measure, take the place of it. He is informed that, should American dealers in this lumber take the necessary trouble to send agents there, they could, without doubt, secure some of this business. An important firm informs him that they purchase $400,000 worth of oak lumber per year, and that, could they form the proper connections in the United States, they would undoubtedly purchase the entire amount there. They have had small lots of American-grown oak, and state that it has proved satisfactory. Much of this oak lumber is used for cooperage and flooring. The demand is for planks from 6 to 36 feet in length and from 7 to 16 inches in width. The planks sawn from the heart of the tree should be from 9 to 36 feet in length, the average width being 9 inches and the thickness from 1 to 2¾ inches. Planks sawn at right angles with those sawn from the heart, called here the "quartier," should be from 6 to 36 feet in length, from 1 to 2 inches thick, and of an average width of 9 inches.

The planks cut from the corners of the log, between the heart of the tree and "quartier," are used for flooring. The length should be about 6 feet, thickness 1 inch and width about 7 inches. Oak lumber, cut square, is used in considerable quantities also, the sizes approximately being 2¾ by 2¾ inches, 3¼ by 3¼ inches, 4 by 4 inches, 3¼ by 4 inches, 3¾ by 4¾ inches. To meet the requirements of the trade all planks should be clear and free from sapwood, bark, etc. There should be no knots or wormholes in first-quality lumber. Sound knots are accepted in second quality. Red oak lumber is not wanted, on account of the wormholes, it not being salable even as second quality.

The Consul offers to put American dealers in communication with dealers in France.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY BY R. M. VAN ARSDALE, MORSE BUILDING.......NEW YORK

M. N. FORNEY, W. H. MARSHALL, } Editors.

MAY, 1897.

Subscription.—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*

Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

From and after this date the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL will be under the editorial management of Mr. George M. Basford, for some years past editor of the Railway Review of Chicago. Mr. Forney, after more than 25 years of active service, has retired from editorial work. Mr. Marshall has accepted an appointment as Assistant Superintendent of Motive Power and Machinery of the Chicago & Northwestern Railway. The readers of this paper will, doubtless, unite with its proprietor in wishing the retiring editors long life and prosperity.

The Holman locomotive has not been taken seriously by railroad men. The idea of placing a pyramid of friction wheels under each driving wheel to multiply speed is not very attractive. To add five wheels under each driver, making a total of 20 for an 8-wheeled and 30 for a 10-wheeled locomotive, appears to sensible men as a joke. But evidently some people will consider it a poor joke before they get through with it. The advertisement of the stock of "The Holman Locomotive Speeding Truck Company" in the New York Sunday papers says that 1,000 shares of the stock are for sale at $50 per share. We learn from private sources that it is being bought in considerable quantities. The capital stock of the company is $10,000,000. Why is it that inventions of genuine merit are so often difficult to finance, while absurdities like the Holman locomotive can find ready support? This mechanical monstrosity will be dangerous at high speed, will produce much friction, consume more coal than the common locomotive doing the same work, will be expensive in first cost and maintenance, and has not one redeeming feature that we can discover.

Whatever may be the final outcome of the large-car problem as applied to box cars and other equipment that is interchanged extensively between railroads, there seems to be little question but that 100,000-pound capacity cars will be extensively used for coal and ore. Inquiries which we have made reveal the fact that a number of the recent designs for 70,000 and 80,000 pound coal and ore cars (from which many have been built) were from the start made strong enough to take 100,000 pounds by putting heavier trucks under them. Then again all those interested in the numerous designs of freight trucks that are coming to notice are providing for a carrying capacity of 100,000 pounds per car. The recent order of 600 steel cars for the Pittsburgh, Bessemer & Lake Erie road is for cars of this capacity. These cars are to be of metal—steel trucks, steel underframes, etc.—and it looks as if in the near future those roads having a heavy and regular traffic in coal and ore would carry that material in metal cars of 50 tons capacity.

A contemporary notes that several axles have broken under motor cars on the Brooklyn Bridge, and argues that the strains on a motor axle are evidently different in character and much more severe than those to which an ordinary car axle is subjected, and that an especially great torsional strain is likely to exist at the instant of starting. The motor axle, it is said, should be very much heavier than an ordinary car axle, but how much heavier can only be determined by experience such as the Brooklyn Bridge cars are now having. The facts of the case are that there is nothing mysterious in these breakages. Taking the known weights on these axles, and calculating maximum stresses by the methods given in the recent report to the Master Car Builders' Association on 80,000-pound car axles, those stresses are found to be more than 50,000 pounds per square inch. The only mysterious thing about these axles is that they did not all break. They are only 4¼ inches at the wheel fit, and will all have to be replaced by new axles which should be 5⅝ inches in diameter, but which cannot be made more than 5¼ inches because of limiting conditions. Somebody probably guessed at the dimensions of the smaller axles. The material was of the best and the new ones will be of the same manufacture.

It seems strange that at this late day there should be any uprising of labor through the introduction of labor-saving machinery. And yet for more than a month the Amalgamated Engineers in England have been threatening a strike because an employer introduced a new boring machine so nearly automatic in its operation as not to need the attendance of a skilled workman. Such opposition to progress hurts the interests of workmen and employers alike. It has been thoroughly demonstrated that labor-saving machinery in the long run creates a demand for labor through the cheapening of the finished product and the greater demand which arises for it in consequence. On the other hand unreasonable resistance to genuine progress on the part of workmen is only an incentive to the employer to get rid of them whenever he can. The inventor of a labor-saving machine, who in exhibiting it, placed on it a placard which read, "Can do the work of 10 men; never gets drunk; never goes out on a strike," appreciated the needs of possible buyers of his machine and was not slow to point out the failings which too many workmen exhibit. Honesty, industry and steadiness, combined with a recognition of the inexorable laws of advancement and progress, are qualities which invariably elevate their possessors, and ultimately triumph over all obstacles. Workmen who possess such qualifi-

cations are seldom injured by such temporary fluctuations of the labor market as arise from the extending use of labor-saving machinery.

Retributive justice has recently overtaken one of the line officers in our navy who was instrumental in the ruin of the great shipbuilder John Roach. Among the candidates for the vacancy of the Navigation Bureau, caused by the retirement of Admiral Ramsay, was a line officer who was a member of the board which 12 years ago, after the trial trip of the *Dolphin*, declared the vessel to be structurally weak and unfit for sea service. Afterward the *Chicago*, *Boston* and *Atlanta*, which were under construction at Roach's yard, were removed to the Brooklyn Navy Yard and completed by the government. Since that report of the board the *Dolphin* has cruised around the world and in every way proved herself to be an excellent boat. In explanation of that report it is claimed that the naval officers were at that time unfamiliar with steel vessels and ignorant of the extent to which vibration from machinery could be present without indicating structural weakness. But ignorance of this kind is no excuse for the sweeping report which brought to a sorrowful end the career of a great and honored shipbuilder. If our government was entering upon an era of steel shipbuilding it was the duty of naval officers upon whose reports such vessels were to be accepted to become familiar with them. Furthermore, this officer is one who has been active in opposing the just claims of the engineer officers, and has treated their arguments with that contempt which is incompatible with unprejudiced investigation of the merits of this case. Hence, his course of injustice to those in and out of the navy makes it peculiarly fitting that his aspirations should in this case be unsatisfied, and that he should remain in a position where he will do less injury to the righteous cause of the staff officers than he might exercise in the Navigation Bureau. The friends of John Roach and the friends of the engineers in our navy will view with complacency the course of justice.

The Army and Navy Journal suggests to a prominent ex-naval engineer who has actively espoused the cause of the engineers in our navy, that he might turn his attention to foreign navies in a study of accidents at sea, and then goes on to recite the history of several accidents to the machinery of foreign vessels. If we mistake not, the trouble is not with the machinery in our vessels of war but rests with the men who command these vessels. The line officers in their fight against the engineers have augmented their own numbers until it is impossible to give each commander, captain and navigating officer that experience at sea which will make him competent. Hence we have the *Brooklyn* going aground on a ledge as soon as she leaves the builder's yard, and sustaining damages that cost $130,000 to repair, the *Texas* running aground in Newport Harbor, the *Montgomery* scraping the rocks off Governor's Island in New York Harbor, the *Cincinnati* accomplishing the same feat in Hell Gate, etc., etc. And in every case no one is to blame, according to the findings of those remarkable boards of inquiry for which our navy has become famous. When the *Cincinnati* struck something hard at Hell Gate about two years ago, the verdict of the intelligent board of inquiry was to the effect that the something was a submerged wreck, though this finding evidently fails to explain why pieces of rock were found imbedded in her propeller. The submerged wreck excuse worked so well in that case that it was resorted to again to explain why the *Montgomery* got into trouble off Governor's Island last summer. In that case also those who know say that fragments of rock had to be removed from the propeller. We might touch on many other cases to show that the line officers of our navy need more experience in actual service and less protection by boards of inquiry, if our navy is to be an efficient one, but it is hardly necessary to do so when the daily press is constantly supplying exidence in this direction. The people are beginning to understand. A recent issue of Puck holds the navy in ridicule by publishing "a nautical operetta in one act" in which the captain of a U. S. battleship is supposed to receive orders to take his ship to sea, and in attempting to leave the dock the ship runs down a fishing smack, is sunk in the mud and the crew rescued by the fishing smack.

Our line officers may be men of ability, but what is needed is a better organization in our navy: fewer and therefore more experienced line officers, more engineers, a proper recognition of the latter, and no favoritism to anyone. Our vessels may not be perfect, but they are so much superior to our naval organization that it is almost useless to discuss them until the personnel of the navy is reorganized.

THE REJECTED HEAT OF GAS ENGINES.

We publish elsewhere in this number an abstract of a paper on the possibilities of utilizing the heat rejected by gas engines. The author shows that approximately 75 per cent. of the total heat of combustion is discarded by the gas engine, part of it going to the jacket water and the remainder escaping with the exhaust gases. He proposes to utilize this waste heat in one of two ways; to generate steam for steam engines or to heat the building in which the gas engines are placed. Such methods of utilizing waste heat may be possible of execution, but we doubt if they can be made practicable. Gas engines are usually installed because they are more desirable or economical for certain conditions than are steam engines and boilers, and it is hardly conceivable that both steam and gas engines would be installed in the same plant. The first cost of the installation and its inelastic nature, arising from the steam engine being as dependent upon the gas engine as the lower cylinders of a multiple expansion engine are upon the high-pressure cylinder, are both against such an arrangement. To utilize the waste heat for heating the building is more feasible, but at times the heat supplied will be too great, at other times too small, and in summer the heat would have to be discarded entirely.

The further development of the gas engine does not lie in the utilization of its wastes, but in their prevention or reduction. The exact manner in which this desirable end is to be obtained we cannot predict, but it is well to bear in mind that while in the steam engine the enormous amount of heat rendered latent in the working fluid is a barrier to the achievement of any remarkable economies over the best modern practice, there is no such obstruction to progress with the gas engine. In the latter we have to deal with high pressures and temperatures and various difficult problems arising from them, but these are physical and mechanical problems, and, though difficult, they are not by any means to be classed with the impossible. Take, for instance, the loss of heat to the jacket water. At present that loss is great for three reasons; first, the surfaces exposed to the hot gases are usually unnecessarily large; second, the lubrication of the piston by present methods will not permit of any higher average temperatures in the cylinder; and, third, higher average temperatures also give trouble from premature explosion of the charge. To these reasons might be added the statement that much of the heat prevented from going to the jacket would be lost through increased temperature of the exhaust unless ways were devised to utilize it in work on the piston. It is evident, however, that all these matters are largely mechanical problems that will some day be at least partially solved. Take, for instance, the area of the surfaces exposed to the hot gases at the moment of explosion in a 10 by 15 engine; if the clearance is 20 per cent. of the cylinder volume, that space would be represented by a cylindrical chamber 10 inches in diameter and three inches long, the total area of whose surfaces would be 251 square inches. This we may consider as the minimum area which can be reached by good mechanical arrangement of parts. How far many engines fall short of the possible in this direction may be inferred by an examination of the ports and other excrescences on the combustion chamber, by which the total area exposed is sometimes as great as 400 square inches for an engine of the size considered.

The question of lubrication will doubtless be ultimately solved by preventing the gases when at the higher temperatures from

coming in contact with the surfaces whose lubrication is so difficult. This matter of lubrication, together with that of the danger of premature explosion when less heat goes to the jacket, may be solved in part by a better utilization of the heat in work on the piston. The gases are usually at a pressure of from 30 to 50 pounds, when the exhaust valve opens, and are thus deliberately thrown away while their temperatures and pressures are such as to make them capable of doing considerably more work. If exhausted at a pressure as low as would be commercially practicable in view of the size and friction of the engine, the efficiency of the engine would not only be directly increased by the work done and the lower temperature of the exhaust, but by lowering the average temperature of the cylinder, proper lubrication and absence of premature explosion would be possible even when much less heat went to the jacket water, thus producing an indirect gain of no small magnitude.

Every improvement in a gas engine that prevents the waste of heat prior to exhaust raises the pressure of the gases at exhaust and calls for a larger cylinder if the full benefit of the improvements is to be realized. But large cylinders, with high pressures of explosion, call for increased strength and weight throughout the engine, and these influence its first cost and its mechanical efficiency. The fact that successful gas engines have only one working stroke in every four causes the practical limit to enlargement to be reached more quickly than in steam engines. Double-acting engines and single-acting engines with an impulse every revolution have been tried repeatedly, and in general have been failures, but we believe that ultimately they will be made a success, particularly for large powers. The four stroke cycle, because of the simplicity of construction possible where it is used, may never be abandoned for small powers, but when large installations become common we think power will be furnished on more than one stroke in four. If this desirable end is accomplished then the mechanical efficiency of the engine may be increased, and the cylinders can be made large enough to derive the full benefit of improvements in thermal action without overstepping the bounds of practicability. The construction of a satisfactory impulse-every-revolution engine is not easy; Mr. Dugald Clerk, a high authority who has spent many years upon it, says it is one of the most difficult mechanical engineering problems of which he has knowledge; but a search after the possibilities of improvements in the thermal action of gas engines shows so clearly the commercial limitations placed upon the engineer by the four-stroke cycle that one is driven to the belief that at some stage in gas-engine development it will be abandoned for a shorter cycle.

It is impossible to go over the whole field of gas-engine cons.ruction in a single article, but we have said enough to show that engineers have before them many channels in which they can labor for the improvement of the gas engine, and which promise far better results than to place it tandem with a steam engine.

SALT-WATER FEED FOR WATER-TUBE BOILERS.

It has been the general belief of engineers far years that salt-water feed could not be successfully used for any length of time in water-tube boilers, because of trouble from priming and the rapidity with which the tubes would be stopped up. But leaky condensers are not entirely unavoidable, and when they do leak; salt water must be used in the boilers until they are repaired or the vessel is without power and helpless. While this argument has applied to all water-tube boilers and has undoubtedly been one of the factors in the prevention of their general introduction on large ocean-going vessels, it has been used with special force against propositions to employ in large vessels the small-tube or "express" boilers. The small tubes of boilers of this class give them great advantages in the way of quickness of steaming, light weight and great capacity, but evidently if salt feed will give trouble at all, it will produce it more quickly in small tubes than in large ones. Under the pressure of these views the use of the small-tube boilers has been confined chiefly to torpedo boats and destroyers, where the enforced reduction of weight made their use imperative.

But the demand in both naval and merchant marine construction for a reduction in the weight per horse-power of engines and boilers, either to permit the use of more power in a boat or to utilize the saving in weight and space for other purposes, has led to some notable installations of the large-tube water-tube boilers. Perhaps the most striking case has been the 25,000 horse-power of Belleville boilers put into the new British cruiser *Powerful* and her sister ship. And now Mr. Yarrow, the well-known builder, comes forward with the results of experiments conducted by him on the use of salt-water feed in Yarrow boilers. He took a second-class torpedo-boat 86 feet long and of 15 tons' displacement, fitted with a Yarrow boiler and triple-expansion engines of 250 horse-power, giving the boat a speed of 17 knots, and ran it successfully many trips of from 4 to 8½ hours' duration, using salt-water feed. The boat would leave the yards of Yarrow & Company with its condenser in operation and everything normal until it was out of the river and running in sea water of average density; then the main feed would be shut-off and the feed from the sea started and kept going until the density rose to figures ranging from 1½/32 to 4½/32; then the main feed and the sea feed would be employed alternately to maintain the density, and under these conditions the boat would steam at full speed from 7½ to 8½ hours. In six trials, whose logs are published, the troubles from priming were practically nothing and the deposits in the boiler were slight. An account of one trip, with newspaper representatives on board, says that there was a little priming when the sea feed was first started, but that it quickly stopped, and in 4½ hours of steaming at full speed, using salt feed all of the time, the working of boiler was very satisfactory.

From these trials it would appear that "express" boilers can be made to operate successfully for many hours in case of a break-down of a condenser, and thus one argument against their use in large boats is exploded. The Engineer, in commenting on the trial, says: "We see no reason to doubt that if the Yarrow boiler were worked with sea water, and properly blown down and scummed, it could be run for a month without trouble; whether equally satisfactory results could or could not be obtained with other water-tube boilers we are not in a position to say. Each type of boiler will have to be made the subject of special experiment. The important fact with which we have to deal is that boats fitted with the Yarrow straight-tube boiler can be run up to three-quarter speed at all events with sea water. Of this there can no longer be any doubt."

Another conservative opinion illustrative of the changed opinions towards these boilers is furnished by Engineering, which, in a recent issue, while dealing editorially with a discussion in Parliament on the navy estimates, says: "The small-tube or express boilers of the Thornycroft or Yarrow type have done so well in the torpedo-boat destroyers that confidence in them has been greatly strengthened of late. The work required from a boiler in torpedo craft is of a very trying nature, and though the vessels themselves are small, the power of their machinery is great. For instance, at full speed a torpedo-boat destroyer's engines exert as much power as the *Powerful's* engines do when the latter vessel is steaming at her economical speed, and some of the latest torpedo-boat destroyers now under construction will have machinery not far from one-third as powerful as that of the big cruiser. On another page we give an account of trials made with a Yarrow boiler which should do much to inspire confidence in this type of steam generator, and it may be remembered that the *Speedy* has now been in commission for four years with Thornycroft boilers, which have been remarkably successful. When one remembers the immense saving in weight which is gained by the use of the small-tube boilers, and the many advantages in other respects, it is difficult to resist the conviction that they will make their way to the front, and we shall see them not only in war vessels, but in nearly all vessels in which high speed is a leading feature in the design. Probably it will be found that between the return-tube boiler and the express boiler there will not be much room for the large-tube variety, unless some new departure and great improvement be introduced."

NOTES.

The students of the department of mechanical engineering of the University of Illinois, under the direction of Prof. L. P. Breckinridge, are about to begin a series of locomotive tests on the Illinois Central Railroad. The engines selected for test are two 18 by 24 and four 18 by 26 passenger engines, one 19 by 26 mogul freight engine and one 21 by 24 consolidation engine.

Press dispatches state that there is bad news about Bazin's famous roller steamboat which was expected to revolutionize marine architecture. The recent trial trips at Roen have been discouraging, the engines not proving powerful enough. Their force was trebled, but the increased weight submerges the rollers deeper than is judicious, and they only turn ten times a minute, instead of forty. The rollers throw up such quantities of water behind that it acts like a brake and reduces the expected thirty knots an hour to six or seven. Rubber scrapers are being experimented with to prevent the upheaval of the water.

The elaborate experiments by Germany to ascertain the best colors for warships have led to the conviction that olive green, which is favored by the United States Navy in time of war, is the best, because it renders ships last visible to an enemy. It is true that dark brown has great advantages by day, but there is no doubt that olive green is the hardest to make out at night. During the rebellion of the rebellion of the Brazilian fleet under Admiral Mello in 1894, the loyal ships were painted olive green, which enabled the torpedo boats to approach the rebel flagship *Aquidaban* within 400 yards undetected and destroy her.—New York Sun.

Superintendent Charles Selden, of the B. & O. Telegraph, said the other day that the average number of messages handled every day on the B. & O. system was 53,000, exclusive of train orders. The B. & O. has 22,252 miles of telegraph wire, of which they use 7,240 for company's business and the balance is leased to the Western Union. There are 384 telegraph offices on the line of which 234 are reporting Western Union offices. Mr. Selden employs in his department 750 men, exclusive of linemen. He also has charge of the block signal offices which east of the Ohio River average one to every six miles. The service of the company's plant is considerably augmented by the use of several multiplex systems.

The acme of German shipbuilding is represented by the new German express steamer *Kaiser Wilhelm der Grosse*, built at the Vulcan Works, Stettin, and it would appear that the new vessel will prove no unworthy compeer to the splendid boats now crossing and re-crossing the Atlantic. The ship indicates about 28,000 horse-power, providing for a minimum speed of 22 knots. The chief dimensions are, between perpendiculars 625 feet, 66 beam, and 43 feet molded depth. The twin-screw engines are of the four-cylinder triple-expansion type, with cylinders of 52, 90, and two of 97 inches diameter, with a stroke of 69 inches. The *Kaiser Wilhelm der Grosse* is considered the finest vessel ever built in Germany.—Industries and Iron.

It is understood that as the result of experiments recently made at Woolwich and elsewhere, the British government has decided to materially reduce the proportion of nitro-glycerine at present employed in the manufacture of cordite. The proportion now being used is 58 per cent., which is much higher than that used by any other government. Mr. Maxim, we believe, prior to taking out his patents, experimented with smokeless powders, containing up to 60 per cent. of nitro-glycerine, and after some 5,000 trials selected a proportion of 16 per cent. as giving the best results as combined with safety and stability. It is obvious that any nitro glycerine powder must necessarily be a compromise, but the safety margin the government has chosen appears to be very small.—Industries and Iron.

If we can credit the European despatches in the daily press there is a possibility of the steam turbine for marine purposes being given a trial on a large scale. Those despatches state that it has been freely rumored at Newcastle-on-Tyne that the Cunard company's engineers are thinking of trying the new marine turbine system on their next steamer. The system was referred to in these columns. Further trials have recently taken place with the little steamer *Turbinia*, with the result that she showed a mean speed on a measured mile, at the mouth of the Tyne, of 32¾ knots an hour, with remarkably low coal consumption. The experts have reported that, although heavy seas were encountered, "there was no racing of screws and the machinery worked with perfect smoothness and complete absence of vibration." The *Turbinia* is only 100 feet long and 9 feet beam, with a maximum displacement of 42 tons.

The Baltimore & Ohio Railroad Company has decided to inaugurate on May 1 the tonnage system for handling its freight trains. For the past eight or nine months General Manager Greene has been experimenting along this line, and has arrived at the conclusion that the cost of operation may be decreased to some extent by using this plan. It is not expected that a very great gain will be made as the B. & O. for the past year has been loading very close to the limit. The unit system will be the basis for operation on the tonnage system, the unit of weight being 6¼ tons. When cars are loaded or received from other lines, the number of units of weight it contains will be plainly marked on the side of the car, so that the trainmen will have no difficulty in arriving at the proper number of units to place in the train. The use of the unit system renders it very easy for trainmen to figure on just how many tons they are handling and does away with the use of five and six figures in addition.

At a meeting of the Civil Engineers' Society of St. Paul, held April 5, some data were presented on the shearing value of wire nails in pine planks obtained from tests made at the State University. The general results of about 200 tests of the various sizes of nails, in white and Norway pine, were given. A white pine joint held by one 6d. nail begins to yield at about 70 pounds of shear and gives way at about 160. Held by a 60d. nail, the corresponding figures are 370 and 820, the maximum figure in all cases being about twice that which indicates the point of yielding. Roughly the strength of the joint is the cube of the diameter of the nail into 50,000. The largest nails can be driven 1¼ inches center to center, and nearly the full value of the nail is effective. For instance, the result from one 50d. nail to the joint was 347 and 800, while the average of nine 50d. nails to the joint was 294 and 790 per nail. These experiments will be extended and the results tabulated and digested, and at a future meeting of the society will be discussed.

It appears clear that in a few more years we shall have to look beyond Bilbao for the six millions or so of tons of ore we are now annually importing from Spanish territory. Professor Windsor Richards pointed out three years ago that the Bilbao mines were becoming exhausted. The recent visit of the Iron and steel Institute to Bilbao has aroused some notice of this important fact among those interested in the American ore and iron industries, who are confidently predicting that during the course of the next five or six years a great change will come over the comparative circumstances of iron and steel production. While the ore supply of Great Britain is failing, America, it is pointed out, has ore resources whose extent and duration are both at present incalculable; while English ores are growing dearer, those of America are growing cheaper, with the certain result, as one influential organ puts it, "that cheap coal. coke and iron ore together are likely, in the next five years, to put American iron products in a position that will vindicate the policy of protection before the world."—*Industries and Iron (London).*

From the accounts of a series of tests of the accuracy of the Le Chatelier pyrometer made by Doctors Holborn and Wier, in the government physical laboratory, at Charlottenburg, and published in the Magazine of the Austrian Engineers' and Architects' Society, it appears that it is possible to record temperatures up

to 1,800 degrees C. with a limit of error of one-half of 1 per cent. In standard of accuracy was an air thermometer. The Le Chatelier pyrometer consisted of a thermo-electric couple and a galvanometer. The thermo-electric couple was formed by two wires enclosed in a glazed porcelain tube. One wire was of platinum and the other an alloy of 90 per cent. platinum and 10 per cent rhodium. The tube was one meter long and 35 millimeters (1¼ inches) in diameter, and the wires within were, of course, insulated for their entire length, except at one end where they joined. The electric current generated by the couple is proportional to the temperature, and was measured by a galvanometer with stationary permanent magnet and a movable coil, and which was wound specially for the detection of feeble currents.

The Navy Department will soon receive bids for the construction of two 30-knot torpedo boats and one destroyer of 31 knots, the latter to be one of the largest boats of her class constructed for the navy. The other two will be smaller, and much like the boats now building at Bath and the Union Iron Works. The department will also contract for the building of a steel composite practice ship for the naval cadets, on the design of the *Newport*, now nearing completion at Bath. This ship will have ample supply of sail power, will be clipper built, and of 13 knots speed. She will cost when in commission nearly $300,000, and will be one of the best boats of her class commissioned. Capt. Cooper, Superintendent of the Naval School, who appears to belong to that class of line officers who have not yet waked up to the changed conditions brought about by the introduction of steam power, has opposed the building of a steam and sail ship, and believes that a simple sailing vessel without steam power is better adapted for use in instructing cadets in practical seamanship. His views have not been approved, however, by the naval authorities, who believe that the days are past when sail power will ever be important in propelling war vessels, and that young officers should be exercised on vessels similar, as far as possible, to those they will have to command. The authorities would have been blind indeed if they had arriyed at any other conclusion after the incapacity which some officers of the sailor class exhibit on board our modern steamships.

The Great Eastern Railway Company, which has been doing smart work of late in replacing some of their bridges which span rivers in a single night, beat its own record recently, when, in spite of a severe snowstorm, the bridge over the River Lea to the south of Tottenham station, on the main line, was replaced by a new bridge, the old one being removed and the new one placed *in situ* in nine hours. The old bridge was removed and the new one put in its place by the same process and at the same time. Mr. Wilson, the Chief Engineer, with a large body of officials, and gangs of men to the number of 70, were on the bridge soon after midnight with a huge crane, several crabs, a couple of 100-ton jacks and several 50-ton jacks in reserve. At 12:30 a. m. operations were commenced. The first thing to do was to strip the rails from the old bridge, taking up the planking as well as the permanent way, in order that the lifting apparatus could be attached to the girders to raise the whole bridge bodily to the extent of 18 inches. This was to allow of trolleys being placed underneath resting on transverse girders, which had been erected so that the bridge, being elevated on wheels, could be drawn away. The old bridge was 77 feet in length. The new bridge, 84 feet 9 inches in length, had been erected beside the old one, complete even to the rails and its final coat of paint. It had already been provided with temporary wheels to facilitate shifting. The preliminary part of the work—the raising of the old bridge and placing it on wheels—was the most arduous part of the task, and occupied the men incessantly until a quarter to seven. Then, by means of powerful crabs and winches attached to the new bridge, this was slowly pulled into the place of the old, the latter being at the same time pushed out of the way. It was a dead weight to move of 250 tons, but it was accomplished in an hour. At a quarter to eight the new bridge was in its place, and the old bridge was by its side. The next thing to be done was to remove the trolleys or wheeled carriages from under the new bridge and lower it into its final position flush with the permanent way. The completing of this occupied the remainder of the morning, and then the leveling up and adjusting was gone on with; but at 2:20 the engineer's train was able to cross the new bridge, and the work was practically completed.—*Engineering.*

Personals.

Mr. E. L. Russell has been elected Vice-President of the Mobile & Ohio.

Mr. T. J. James has been elected President of the Wadley & Mt. Vernon Railroad.

Mr. Frederick K. Ulman has been appointed Receiver for the Brooklyn Elevated road.

President James Shannon, of the Fonda, Johnstown & Gloversville Railroad, died on March 12.

Mr. Robert Hancock has been elected President of the Atlantic & North Carolina Railroad Company.

Mr. G. A. Nettleton, Chief Engineer of the Ann Arbor road, has resigned, and is succeeded by Mr. O. D. Richards.

Mr. I. W. Troxell has been appointed General Manager of the new Queen Anne's Railroad. Office, Queenstown, Md.

Mr. Thomas Fisher has been appointed Receiver of the Roaring Creek & Charleston, to succeed Mr. C. T. Dixon, resigned.

Mr. M. W. Wilkins is President of the New Albany, Lebanon & Sodaville road in Oregon. Headquarters Waterloo, Ore.

Mr. L. J. Polk, Acting General Manager, has been formally appointed General Manager of the Gulf, Colorado & Santa Fe.

Mr. E. B. Cushing has been appointed Chief Engineer and General Superintendent of the Houston, East & West Texas.

Col. John Magee has been elected President of the Fall Brook Railroad, to succeed his father, the late Gen. George J. Magee.

Mr. Frederick W. Kruse, of Olean, Pa., has been appointed Receiver of the Allegheny & Kinzua road, vice Mr. A. D. Scott.

Mr. David S. Hammond, Treasurer and Purchasing Agent of the Cornwall Railroad, died at his home in Lebanon, Pa., on April 3.

Mr. Charles A. Beach, formerly General Superintendent of the South Jersey Railroad, has been appointed General Manager of the company.

Mr. J. F. Sheahan, Master Mechanic of the Fourth and Sixth divisions of the Plant System, with headquarters at Palatka, Fla., has resigned.

Mr. F. A. Horsey, of New York, has been elected President of the St. Louis & Cairo Railroad Company, to succeed his brother, the late J. H. Horsey.

Mr. W. H. Marshall is appointed Assistant Superintendent of Motive Power and Machinery of the Chicago & Northwestern Railway, with office at Chicago.

Mr. F. F. Gaines has been appointed Mechanical Engineer of the Lehigh Valley's motive power department, vice H. D. Taylor, promoted. Office at South Easton, Pa.

Mr. H. Ridgeway has been appointed Master Mechanic of the Chihuahua Division of the Mexican Central, with headquarters at Chihuahua, to succeed Mr. T. Smethurst.

Mr. H. A. Whiting, Vice-President and General Manager of the Wilmington, Newbern & Norfolk, has been appointed Receiver of that road, with office at Wilmington, N. C.

Mr. Joseph H. Sands has resigned as General Manager of the Norfolk & Western, and the duties of that position will hereafter be performed by Mr. J. M. Barr, Vice-President.

Mr. John Echols has retired from the position of President and General Manager of the Chesapeake, Ohio & Southwestern, owing to the absorption of that road by the Illinois Central.

Mr. James N. Hill, Vice-President of the Eastern Railway of Minnesota, has assumed the duties of General Manager, with headquarters in Duluth, vice Mr. W. C. Farrington, resigned.

Mr. G. W. F. Harper, formerly President and Treasurer of the Chester & Lenoir Railroad Company, has been elected President of the reorganized company, the Carolina & Northwestern Railroad.

Mr. T. C. Sherwood, formerly Assistant General Manager of the Kansas City, Pittsburgh & Gulf, has been appointed General Manager of the Kansas City & Northern Connecting, with headquarters in Kansas City.

Mr. S. C. Dunlap, of Gainesville, Ga., has been appointed permanent Receiver for the Gainesville, Jefferson & Southern Railway, succeeding Mr. Martin H. Dooly, who was appointed temporary Receiver some weeks ago.

The office of Master Mechanic of the Dunkirk, Allegheny Valley & Pittsburg, made vacant by the death of Mr. W. G. Taber, has been abolished. Mr. A. Sherman has been appointed Foreman of the shops at Dunkirk, N. Y.

Mr. J. F. Dunn, formerly Master Mechanic of the Union Pacific at Pocatello, is Superintendent of Motive Power of the Oregon Short Line and Mr. Ira O. Rhodes, assistant to the Purchasing Agent of the Union Pacific, is General Purchasing Agent.

It is reported, on apparently good authority, that Mr. Daniel S. Lamont will become President of the Northern Pacific, in case of the retirement of Mr. Winter, which is made probable by the new relations between that company and the Great Northern.

Mr. E. L. Martin, President of the Kansas City, Pittsburgh & Gulf Railroad, has resigned. Mr. A. E. Stillwell, Vice-President and General Manager, has been chosen to succeed him. Mr. Martin had been President of the road since it was first organized in 1890.

Mr. O. R. Fyler has been nominated to succeed A. C. Robertson of the Connecticut Board of Railroad Commissioners, whose term expires on July 1, and Mr. W. F. Wilcox has been nominated to succeed Mr. George M. Woodruff, whose term expires on the same date.

Mr. George Masson, for the past 12 years Chief Engineer of the Chicago & Grand Trunk, Detrait, Grand Haven & Milwaukee, and other Grand Trunk lines west of Detroit, has been retired under the policy of consolidating the engineering department of the Grand Trunk system.

Mr. George F. Foster has resigned as Master Mechanic and Acting Trainmaster of the Lexington & Eastern, and the offices have been abolished. Mr. E. R. McCuen has been appointed General Foreman in charge of the mechanical department, with headquarters at Lexington, Ky.

Benjamin Butterworth, of Ohio, has heen appointed Commissioner of Patents by President McKinley. General Butterworth held the office once before and there is good reason to look forward to an intelligent and efficient administration of the affairs of the department under his management.

Mr. Albert Foster, Purchasing Agent of the Philadelphia & Reading, died in the Continental Hotel in Philadelphia on April 10. Mr. Foster entered the employ of the Philadelphia & Reading in 1858, and remained with that company until the time of his death. He has been Purchasing Agent since 1890.

Mr. John Hickey, recently Superintendent of Motive Power of the Northern Pacific, had been residing in Denver, where his health has greatly improved. He has now been appointed General Master Mechanic of the Rio Grande Western. This will take him to Salt Lake City, where the climatic connitions are about the same as at Denver.

Mr. W. G. Nevin, General Purchasing Agent of the Atchison, Topeka & Santa Fe, with headquarters in Chicago, has been appointed General Manager of the Southern California, to succeed Kirkland H. Wade, deceased. Mr. Nevin's headquarters will be at Los Angeles, Cal. He has been succeeded as General Purchasing Agent of the Atchison, Topeka & Santa Fe by Mr. W. E. Hodges.

The following changes have gone into effect on the Grand Trunk: Mr. J. W. Harkom has been appointed Master Mechanic for the Eastern Division, with headquarters at Montreal. Mr. W. D. Robb has been appointed Master Mechanic for the Middle Division, with headquarters at Toronto. Mr. William Ballh as been appointed Master Mechanic for the Northern Division, with headquarters at Allandale, Ont.

John King, formerly President and later Receiver of the Erie Railway, died at Beaulieu, near Nice, France, March 17. Mr. King began his railway career on the Baltimore & Ohio, where he finally rose to the position of Vice-President, and President *pro tem.* Later he accepted the Presidency of the Pittsburg & Connellsville Railway, and afterward was Receiver of the Marietta & Cincinnati and the Ohio & Mississippi companies. In 1894 he was elected President of the Erie road, and displayed great ability in reorganizing its affairs.

As a result of the death of Mr. Joel West the following appointments on the Chicago, Burlington & Quincy were announced on April 5: C. W. Eckerson, Master Mechanic East Iowa Division at Burlington, vice Joel West, deceased; J. F. Deems, Master Mechanic St. Louis Division at Beardstown, vice C. W. Eckerson, promoted; J. E. Button, Master Mechanic East Iowa-Ottumwa Division, vice J. F. Deems, promoted. Four days later Mr. Eckerson died suddenly of heart disease while on a train that was leaving St. Louis. Mr. Eckerson had been connected with the Chicago, Burlington & Quincy Railroad for 27 years.

Joel West, Master Mechanic of the Iowa lines of the Chicago, Burlington & Quincy road at West Burlington, Ia., died at Los Angeles, Cal., on the 23d instant, of Bright's disease. Mr. West entered railway service in 1856 as a machinist on New York Central road. He went to the Burlington road in 1857 as a machinist at Quincy, Ill., and became General Foreman the following year. In 1863 he was appointed Master Mechanic of the Galesburg & Quincy and Burlington & Quincy branches, and in 1876 he became Master Mechanic of the Iowa lines of the same road, which position he held at the time of his death.

New Publications.

THE MATERIALS OF CONSTRUCTION. A TREATISE FOR ENGINEERS ON THE STRENGTH OF ENGINEERING MATERIALS. By J. B. Johnson, C. E. John Wiley & Sons, New York; Chapman & Hall, Limited, London. 1897. 800 pages.

In this work Professor Johnson has analyzed and summarized much of the best work done at home and abroad in the direction of establishing fixed laws and principles in the realm of the strength of materials, and has drawn largely upon the works of Bauschinger, Tetmajer, Martens, the reports of the recent French Commission, the records of the tests of the U. S. Test Board and of Mr James E. Howard at the Watertown Arsenal, the series of tests on cements, mortars and concretes at the St. Mary's River canal locks, Kirkaldy's reports and the results of the U. S. timber tests and investigations.

The book is divided into four parts: First, a synopsis of the principles of mechanics underlying the laws of the strength of materials; second, the manufacture and general properties of the materials of construction; third, the methods of testing the strength of materials; fourth, the mechanical properties of materials of construction as determined by actual tests.

In Part I. the behavior of materials under tensile, compressive and bending stresses, etc., are considered. The laws governing the crushing strength of brittle materials are shown for the first time in English. In this part also the resilience of materials is much more fully treated than is commonly done.

In Part II. the methods of manufacture of cast iron, wrought iron, steel, the alloys, cements, and paving brick are each treated very fully, and in addition a chapter of 100 pages is devoted to a scientific and systematic description of timber and timber trees such as has never before been brought together in such a work. The recent Forestry Division investigations on timber, with which Professor Johnson has been so intimately associated, furnish most of the data for this chapter.

In Part III. are described the most approved forms of testing appliances and methods of testing materials. The four large volumes comprising the recent (1895) report of the French Commission, and

the proceedings of the five international conventions on the subject of standard methods of testing materials (Munich, 1885; Dresden, 1886; Berlin, 1890; Vienna, 1893, and Zurich, 1895) have been as freely drawn upon as practicable without destroying the unity of the treatment.

In Part IV. are given graphical representations (stress-diagrams) and text descriptions of the most significant results of tests of all kinds of structural materials made in all parts of the world. Professor Johnson has for the past 12 years been a special student in this direction, since in his capacity as Director of the Testing Laboratory of Washington University, St. Louis, it was his business to inform himself on all such matters, and his many sources of exact information have given this part of the book great practical value. Here also are given a summary of the results of the remarkable series of tests of American timbers (still incomplete), the tests being some 40,000 in number, on 32 species of timber, all of which tests and reductions were conducted by the author of this work in his own laboratory during the past six years.

The magnetic properties of iron and steel, and the methods of determining them, have been incorporated in a valuable chapter written for the author by an electrical engineer. In appendices are given a biographical sketch of Prof. Johann Bauschinger, an excellent account of the microscopic study of iron and steel, by Prof. J. O. Arnold, of Sheffield, Eng.; a synoptic comparison of the recommendations of the international conventions with those of the French Commission, and three sets of specifications for iron and steel for various purposes.

It will thus be seen that the author has produced a book of unusual value to engineers, and from its appearance the publishers have evidently spared no expense in its publication.

THE ELEMENTARY PRINCIPLES OF MECHANICS. Vol. II. Statics By Prof. A. J. DuBois. John Wiley & Sons, New York; pp. 392.

The author says, "The large type by itself constitutes an abridged course, etc." This is a good way of making a large book serve for a smaller one as well as for a larger one; but as we glanced over it we failed to see the distinction in the type that is indicated by the "note." Certainly the difference, if any, is not striking.

There is one attempt at classification both in the headings and in definitions. The title of the book is "Statics," but on the first page of the body of the book the heading is "Dynamics." On page 2 Dynamics is defined, and that heading is carried to page 56, although the discussions for more than 50 pages do not conform with the definition. On page 57 "Statics" is defined and this heading is carried to the end of the work; but problems involving planetory motions, pp. 124, etc., seem to be strangely out of place according to the definition and our ordinary sense of "Statics." Chapter I, p. 228, begins with "Applications," but the distinction between the character of the subjects before and those which follow is not very marked.

There is an effort at nice discrimination in definitions, and some are excellent; but it is questionable whether such refinements would lead one to say that the "direction and speed are changed by the action of another particle." We say so in popular language without being challenged, but we now refer to a critical knowledge of mechanics. Is it not "force" which changes speed and direction On page 7 we read, "When one body presses another it is itself pressed by this other with an equal force in an opposite direction." It says "equal force," and we ask, equal to what? The author might appeal to Newton for authority—who said, "If I press a stone with my finger, my finger is pressed equally by the stone." It seems to us that these statements are not properly discriminating. We should say, if I press a stone with my finger a force is developed between my finger and the stone, which force acts equally in opposite directions. *Every force* acts equally in opposite directions. Laplace said: "That peculiar modification by which a body is transported from one place to another is, and forever will be, unknown—we call it force." More briefly, force is an action between bodies. We learn its laws—at least some of them—and learn to apply them.

"When g must be taken for the locality in feet per second per second." It is so common to retain the same unit throughout a discussion that it seems unnecessary to repeat the "per second." If one is liable to change the unit of time, may he not change the lineal measure—say, inches. It would, at least, sound odd to say feet per second per inches per minute. If the author considered it advisable after once writing the expression in full to say that where the second is once named it will be understood as the unit of time used throughout, it would be unnecessary to repeat the "per second."

In a mathematical work the expressions "manifestly," "evidently," "of course," are usually blemishes. They add nothing to the argument or explanation, and sometimes are seemingly used to avoid explanations. This work is comparatively, though not entirely, free of them.

On pages 320-321 are twelve numerical examples to be found in Merriman's Mechanics of Materials; on page 363 eight examples from Wood's Resistance of Materials; pages 256-262 are much like Merriman's Retaining Walls and Masonry Dams; these, and others, are not credited. It is a delicate question to say how much work of others may be used without credit. It is said that the contemporaries of Laplace complained of that eminent man for utilizing their productions without credit. The action did not heighten their estimate of the man.

But none of these things affect the essential merits of the book for a student. The student can obtain from it a good knowledge of the subject. The applications are numerous, many of which are fully worked out and a sufficient number unsolved to test the knowledge and ability of the reader.

ELECTRIC POWER TRANSMISSION. A Practical Treatise for Practical Men. By Louis Bell, Ph. D. The W. J. Johnston Company, New York, 1897. 491 pages; $2.50.

The author states in his preface that this volume is designed to set forth in the simplest possible manner the fundamental facts concerning present practice in electrical power transmission. He endeavored in introducing such theoretical considerations as are necessary to explain them in the most direct way practicable, using proximate methods of proof when precise and general ones would lead to mathematical complications without altering the conclusion for the purpose in hand, and stating only the results of investigations when the processes are undesirably complicated. In writing of the many-sided and rapidly changing art, it is impossible in a finite compass to cover all the phases of the subject or to prophesy the modifications that time will bring forth; hence the epoch of this book is the present, and the point in view chosen is that of the man, engineer or not, who desires to know what can be accomplished by electrical power transmission, and by what processes the work is planned and carried out.

The first chapter is devoted to elementary principles and is to be commended for the clearness of its style. In the second chapter the general conditions of power transmission are considered, electric, wire rope, hydraulic, compressed air and gas transmission being discussed. Power transmission by continuous and alternating currents is next taken up, and in a chapter devoted to "Current Reorganizers," commutators, motor dynamos and rotary converters and transformers are considered. Chapter vii., on "Prime Movers" is almost wholly devoted to steam engines and water wheels, other prime movers being used so infrequently as to require no attention in a work of this kind. Chapters on hydraulic development, the organization of a power station, line construction, centers of distribution and the commercial problem conclude the work. The last-mentioned chapter presents the cost of horse-powers from steam and water-power, the various other costs such as interest, depreciation, labor, supplies and maintenance, and such items as are needful in determining whether a proposed power transmission plant will pay.

The author's style is clear and concise, and the book will undoubtedly be very favorably received.

Books Received.

STATISTICS OF THE RAILWAYS OF THE UNITED STATES, 1895. The Interstate Commerce Commission, Washington, D. C.

COMMERCE AND NAVIGATION OF THE UNITED STATES, 1896. Volume II. Bureau of Statistics, Treasury Department, Washington, D. C.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CATALOGUE NO. 24 OF THE PEERLESS RUBBER MANUFACTURING Co., 16 Warren street, New York. 120 pages, 5¾ by 8¼ inches (Not standard size.)

This neat and attractive catalogue presents an imposing array of mechanical rubber goods, and is believed to be one of the most

complete lines of such goods offered to the trade. In the earlier pages of the catalogue is described various kinds of packing, the first of which is "Rainbow" packing, a sheet packing adapted for air, steam or water joints, unaffected by oils, ammonia, liquors or alkalies, and does not harden or crack. The company has sold over 4,000 tons of this packing in the last five years. "Eclipse" tubular gaskets is another of the company's products that has been favorably received everywhere. One great convenience in its use is that one can promptly make any size of gasket without waste of material. The Peerless piston and valve-rod packing has a round red rubber core covered with soft loosely woven duck impregnated with plumbago. It will hold 400 pounds of steam. It is made in various sizes and styles. The graphite pump packing, made especially for Westinghouse pumps, is well known to our readers. The company also makes a square braided flax rod packing and an excellent hydraulic packing.

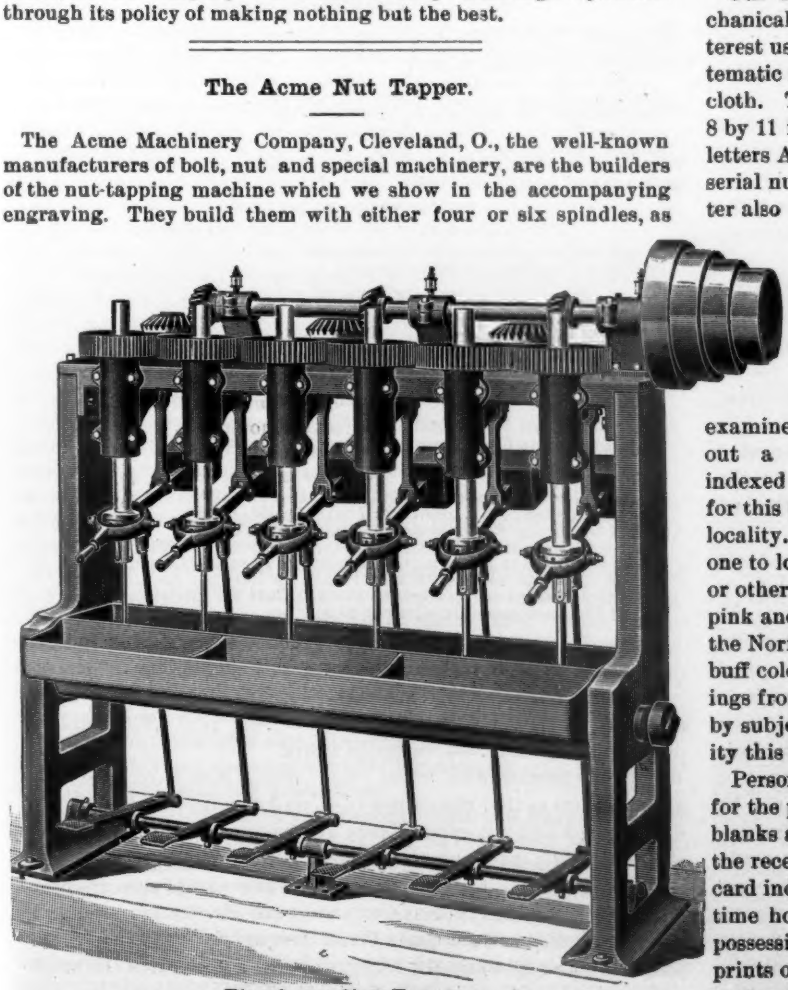
"Rainbow" rubber belting is listed in all sizes up to 60 inches in width and 8-ply in thickness. The very best of material and workmanship enter into its manufacture. "Durham" and "Peerless" are other well-known brands of this company's belting. The section of the catalogue devoted to belting contains many valuable suggestions on the care of both rubber and leather belting. The company produces leather belting too.

The line of rubber hose manufactured by this concern is a large one, and our readers are aware of its excellence. It includes engine and tender hose, air brake hose, signal hose, steam hose, hot water hose, fire hose, etc., etc. Thirty pages are needed to describe and illustrate the many kinds. Other goods listed in this catalogue include rubber mats of all kinds, landing pads, gage glass rings, pumps valves, hose pipes, rubber fire buckets and pails, gas bags, tubing, rubber cement, rubber springs, rubber mallets, wringer rolls, etc.

It would be a superfluous for us to dwell on the excellence of these goods, for the company has achieved its present high reputation through its policy of making nothing but the best.

The Acme Nut Tapper.

The Acme Machinery Company, Cleveland, O., the well-known manufacturers of bolt, nut and special machinery, are the builders of the nut-tapping machine which we show in the accompanying engraving. They build them with either four or six spindles, as



The Acme Nut Tapper.

may be desired, and in three sizes; the smallest size will drill holes from ⅝ inch to 1 inch in diameter, the next size from ⅛ to 1⅛ inches, and the largest size from ⅛ to 2 inches in diameter. The spindles are arranged to be driven in pairs and the pairs can be run at different speeds or all at the same speed. The driving mechanism is extremely simple and the spur and bevel gears are all cut from the solid, insuring a smooth and practically noiseless running of the machine. Quick-acting spring sockets are used, so that the machine need not be stopped for the removal or insertion of the taps.

The Acme Machinery Company makes a specialty of bolt cutters, nut tappers, bolt headers and forging machines, and their machines are well designed and equally well built. Their catalogue describes a great variety of the machines of this class turned out by them.

Norfolk & Western Notes.

In visiting the headquarters of the mechanical department of a railroad company it is usual to devote much attention to the shops and the machinery, special devices and methods employed in them. We feel, however, that if in briefly describing what we saw on the occasion of a recent visit to Roanoke, on the Norfolk & Western Railroad, we confine ourselves chiefly to the methods employed in the administration of the mechanical department, it is only a merited testimony to the excellence and thoroughness of those methods, and no reflection upon the shops.

The office building of the railroad company was burned about a year ago, and a new structure is in course of erection on the site of the first one. In the meantime Mr. R. H. Soule, Superintendent of Motive Power, has his headquarters in a near-by office building. The shops are only a short distance away, and there all the other officers of the mechanical department have their offices, except Mr. Sanderson, Assistant to Mr. Soule, who has an office adjoining his chief.

Our first visit was to the office of Mr. G. R. Henderson, Mechanical Engineer for the company, and we found much to interest us there. The drawing-room work is conducted in a systematic manner. Drawings are made in pencil and then traced on cloth. There are seven standard sizes for drawings ranging from 8 by 11 inches to 36 by 59 inches and these are designated by the letters A to G inclusive. Each tracing when finished is given a serial number prefixed by the letter indicating its size. This letter also indicates the drawer in the fireproof vault in which the tracing is to be kept. Two other letters, H and I, are for miscellaneous drawings received from outside sources, the first embracing those that will fold to 4 by 9 inches for filing, while the last letter is for rolled drawings.

After a tracing is finished the draftsman turns it over to an examiner who examines it in every detail and if correct turns it over to the chief who also examines it in its essentials and when approving it fills out a memorandum by which the drawing is to be card indexed by a subordinate. Printed blanks are provided for this purpose and each drawing is indexed by subject and by locality. This indexing by locality is convenient, for it enables one to look up quickly all drawings pertaining to a certain shop or other point on the line. The card indexing is done on buff, pink and blue cards. All indexing of drawings originating on the Norfolk & Western Railroad are indexed by subjects on the buff colored cards and for locality on the blue cards. All drawings from outside sources which it is desirable to keep are indexed by subject on pink cards, and if it is desirable to index by locality this is done on a blue card. The cards are typewritten.

Persons wanting blueprints order them upon blanks provided for the purpose, and the prints are sent to them with receipt blanks attached, and the parties receiving the prints must fill out the receipts and return them to the office. These receipts are card indexed in such a manner that it can be ascertained at any time how many copies of each drawing are out and in whose possession they are. If a change is made in a drawing all the prints of it are recalled, the card index being consulted for the purpose. New prints are sent out in their place, and these parties, and all others interested, are notified of the change.

An excellent method of filing catalogues also exists in this office. Each catalogue received is carefully examined, and, if considered worth saving, is card indexed. If a leaflet it is put in

a Globe file, but if a book it is placed on one of several shelves that are partitioned off into short sections. These files and shelves are numbered, and each catalogue is marked with the number of the receptacle in which it is filed, so that it can be returned to it readily.

Standard specifications also receive careful attention in this office. Those for materials are printed, but those for equipment are typewritten, as nearly every new order for engines or cars calls for modifications of the previous specifications. Each specification of material receives a number which it retains through all changes that may be made in it. But each time a specification is revised it is given a new letter as a suffix to the number; thus an axle specification might be numbered 18a, but if revised it becomes 18b, and if again altered becomes 18c, and so on. A file of all specifications is kept, in which appears every form of each specification, together with the reasons which led to the changes made and also the source from which the original form of specication was obtained. Thus this file gives a complete history of the standard specifications of the road. A duplicate of this file is kept in Mr. Soule's office for his convenience.

There are a number of the specifications which might interest our readers, but we will refer to one, only because we wish to mention the manner in which the material is tested. This specification is for globes for hand lamps and part of the specification reads as follows:

"Globes must be of clear color and uniform tint. Those having parts or spots of a shade either lighter or darker than the prescribed standard minimum or maximum, or having a cloudy appearance, or showing an improper tint, will be liable to rejection. They must be of approximately uniform thickness, and the globes will not be accepted thinner than three-thirty-seconds of an inch, or thicker than five-thirty-seconds of an inch.

"Manufacturers furnishing colored globes to the Norfolk & Western Railroad Company will be provided with standard minimum and maximum globes.

"Each red globe and about 25 per cent. of all green and blue globes will be tested by the Railroad Company at Roanoke by trial in a standard hand lamp, between the maximum and minimum standards, in a dark range about 100 feet long, and the color and intensity of the inspected globes must come between the standard limits."

The "dark range" in which these globes are tested is about 100 feet long, 3½ feet wide and 1 foot high. It has a small dark room at each end, in one of which an observer is stationed, while in the other the globes are placed over three lights placed in a transverse row. Thus standard maximum and minimum globes and the globe to be tested can all be viewed at once. The inspection is quickly and surely made. When first inaugurated this inspection caused the rejection of many globes but now there is little trouble in this respect only four being rejected in the last shipment of 15 dozen.

The railroad company makes its own cast-iron wheels and careful records are kept of wheel mixtures, tests, and of wheels mounted for service. For this purpose a set of printed blanks for reports are used, the first of which is that on which a daily report of wheels made is sent from the foundry to the mechanical engineers' office. This gives the numbers of the wheels cast, their diameter, the kind of chill and the mixture from which they were cast. Another blank gives all the information regarding wheel drop tests and still another gives the results from test bars. This last blank is ruled so that the result of a test can be expressed diagramatically by drawing freehand one line for unchilled and another line for chilled bars. This is done in copying ink, and it is afterward copied in a letter press in the mechanical engineers' office. Other blanks are provided for reporting weekly from the various shops the wheels mounted and scrapped. From these blanks entries are made in three books in the engineer's office. The principal book is one ruled for the record of 10,000 wheels, the wheels being numbered consecutively. Here the date cast, diameter, kind of chill, date put into service, date removed, etc., is entered. If the wheel never left the foundry, but was scrapped for defects, it is so recorded. If it was broken up for test that fact is stated. In the next book the result of wheel drop tests and the mixtures from which the wheels were cast is recorded, and in the third book the results from the test bars are copied, as already stated. Thus everything pertaining to the history of each wheel is so recorded that it can be found on short notice; furthermore, the results of various mixtures can he intelligently studied.

In Mr. Soule's office one of the first things to attract our attention was the manner in which performance sheets are compiled. The coal records are averaged for classes, and individual engine performances do not appear. This method was adopted some time ago, as it was believed the clerical labor involved in individual engine records was not warranted by the results obtained. The question naturally arises as to how the performances of certain classes of engines in a given service are obtained and compared. This is done by having the coal records of a number of engines in each class under investigation reported to the superintendent for a time sufficiently long to give the desired information. It is argued that this is the only reliable method anyway, as the monthly records of individual engines are being constantly affected by various causes which may be traced at the time, but which are forgotton shortly afterward, thus making old individual records unreliable for such purposes. Both locomotives and cars are given on the one sheet and arranged according to divisions of the road. The various headings are as follows:

ENGINE MILEAGE.

Miles Run in Passenger Service.
Miles Run in Freight Service.
Miles Run in Shifting Service.
Miles Run in Maintenance of Way Service.
Total Engine Mileage.
Average Mileage of Passenger Engines.
Average Mileage of Freight Engines (Shifting and M. of W. included).

CAR MILEAGE.

Passenger Car Mileage.
Freight Car Mileage, Loaded.
Freight Car Mileage, Empty.
Total Freight Car Mileage.
Per Cent. Empty to Total Freight Car Mileage.
Total Freight Car Mileage, on Loaded Basis.
(Two Empty Cars Equal One Loaded.)
Engine Mileage and Car Mileage on Mixed Trains are included under Freight Train Mileage, three passenger car miles (loaded or empty) equal to two loaded freight car miles.

PERFORMANCE OF ENGINES.

(Shifting and M. of W. included under Freight).

Pounds of Coal per Car Mile, Passenger.
Pounds of Coal per Car Mile, Freight.

PER 100 ENGINE MILES.

Pints of Cylinder Oil, Passenger.
Pints of Cylinder Oil, Freight.
Pints of Lubricating Oil, Passenger.
Pints of Lubricating Oil, Freight.

PER 100 ENGINE MILES.

Pounds of Waste for Cleaning and Packing, Passenger.
Pounds of Waste for Cleaning and Packing, Freight.

PER 100 ENGINE MILES.

Cost of Tools, Supplies and Sand (M. E. 11)
Cost of Hostlering, Watching and Cleaning, (M. E. 12).
Cost of Operating Water and Coal Stations, (M. E. 16).
Pints of Oil used in Lubricating Passenger Cars per 100 Miles Run.
Pints of Oil used in Lubricating Freight Cars per 100 Miles Run.
Pounds of Waste used in Packing Passenger Cars per 100 Miles Run.
Pounds of Waste used in Packing Freight Cars per 100 Miles Run.
Cost of Locomotive Repairs per Mile Run.

It was formerly the practice to give coal premiums on this road, but they have been abolished.

The cost of lubricating cars has been brought down to a low figure by persistent effort, and is now .058 per 1,000 miles for passenger cars and .054 for freight cars.

Engine breakdowns when they occur result in such considerable delays that the causes of them have been systematically investigated and recorded. Every breakage of locomotive parts is reported to the mechanical engineer's office, and if necessary the report is accompanied with a sketch. These breakages are tabulated and the record in that form is sent to Mr. Soule's office. If it is shown that certain parts break frequently the cause of the weakness is sought and the remedy applied. The cost of the breakages is also kept, and in 1892 it was $1.28 per 1,000 miles, in 1893 it was $1.19, in 1894 it had fallen to 86 cents and last year it was only 52 cents per 1,000 miles. The number of breakdowns per year per engine was 1.32 in 1894, 1.12 in 1895 and 0.81 in 1896—a truly excellent showing.

Every railroad is called upon to make many trials of devices submitted. It frequently happens that these trials are started and then forgotten in the press of routine business. To prevent this Mr. Soule has established a file of "trial records," in which is recorded the history of every trial of a device. For instance, at a regular meeting of the various master mechanics on the road it may be deemed advisable to give a certain brake beam a thorough trial. It may be furthermore decided that the trial will be made on certain divisions of the road, and that a report will be made at the end of six months. All this is duly recorded in the file of trial records, and periodically this file is examined by the chief clerk and parties notified shortly before reports from them are expected. The file is kept up to date, so that the history of every trial as far as it can be written is found therein. This file is an excellent idea, for if it is worth while beginning the trial of any device it is worth continuing to the end, and having an intelligible and trustworthy record of the results.

The reports of general car inspectors are kept in Mr. Soule's office, also copies of all instruction, issued by them. These instructions, though signed by the inspectors, are in reality prepared at headquarters, as it has been found necessary to take this step.

Mr. Soule has in handy form many important records in his office, such as weekly conditions of freight equipment, condition of passenger cars and engines, stock accounts, etc. An excellent engine board, which ornaments one side of Mr. Sanderson's office, was described in this journal for November, 1896.

The Great Siberian Railroad and the Present State of its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

(CONTINUED FROM PAGE 140.)

THE CENTRAL SIBERIAN RAILROAD.

The Central Siberian Railroad from Obi River to Irkoutsk, 1,149 miles long, in consequence of the varying character of the country, is divided into two divisions, viz.:

The first division from Obi River to Krasnoiarsk, having 474 miles of main line and 3 miles of branches.

The second division from Krasnoiarsk to Irkoutsk, having 675 miles of main line and 3 miles of branches.

Besides them to the first division belongs a large branch from Taiozhnaia Station to Tomsk, 59 miles long.

In February, 1893, the Emperor decided that the construction of the Central Siberian Railroad should be begun, and the work was commenced in the same year. The track laying on the first division was completed in December, 1895, and it was opened for traffic in October, 1896. The branch from Taiozhnaia to Tomsk (59 miles long) was begun in July, 1895, and the track-laying was completed in September, 1896.

The cost of construction of the first division (474 miles), was estimated, without rolling stock, at $12,500,000: but this sum was not sufficient, and a supplementary assignment of $1,750,000 was required, so that the full cost of first division (without rolling stock), is $14,200,000, or about $30,000 per mile. The branch to Tomsk is estimated about $1,000,000.

In autumn of 1896 the first division, together with the branch to Tomsk, was opened for traffic, and was nearly complete, excepting a few works, which will be finished in spring, 1897. These works are: The finishing of the slopes of grading, the draining in marshy grounds, the laying of 30 per cent. of switches and sidings, the addition of 20 per cent. of ballast, the finishing of houses, the construction of one water-supply station, the completion of five water conducts, the erecting of superstructure of a bridge across Chulim River, the finishing the earthworks of Krasnoiarsk station, and the construction of repairing works there.

The Second Division of the Central Siberian Railroad, from Krasnoiarsk to Irkoutsk (675 miles), will be completed in the year 1898. The progress of work is illustrated by the following figures, relating to the end of 1896: Clearing 8,968 acres, grubbing 1,078 acres; temporary roads (along the located line), 620 miles; log roads in marshy lands, 27 miles; earthworks on main line, 15,000,000 cubic yards; on sidings, 1,232,000 cubic yards; finishing of slopes, 100,000 square yards; stone ripraps, 724 cubic yards; 15 cast-iron culverts are finished, and 47 stone culverts are in work (36,436 cubic yards of stone work is laid); 316 timber bridges are finished; of the great bridges four across the rivers Sitik, Benesovka, Rybna and Ouri are finished; the abutments of Doima bridge are finished, and the superstructure is in process of erection. Of the Ouda bridge two spans are erected. The foundations of the Yenissei bridge are in process of construction, and the wooden caissons are supplied for that purpose.

The track is laid on 150 miles of main line and 15 miles of sidings; 50 miles are ballasted. The telegraph is ready on the whole line.

Of the line buildings the following are under construction: 82 watchmen's houses, 33 large section houses, 57 small section houses, 48 wells, 104 road crossings, 23 passenger houses, 9 engine sheds (each for two engines), 7 water-tank buildings, 52 station houses for employees and the small repair works.

The cost of construction of the second division of the Central Siberian Railroad (675 miles), without rolling stock, is estimated at $23,400,000, or $34,666 per mile.

In the region of the Central Siberian Railroad, near the Station Kamishet, the first Siberian Portland cement works have been erected. They were built in 1895 and supply 2,500 barrels of cement each month for the Central Siberian Railroad, at the price of $6¼ per barrel.

Another great enterprise connected with the construction of the Siberian Railroad is the development of the Nicolaievsk Iron Works, on the Angara River, and in the vicinity of the Central Siberian Railroad (about 130 miles from the station Nijne Oudinsk). This plant has had three old blast furnaces, one Siemens-Martin steel furnace, one old steam engine of 600 H. P., and many obsolete rolling mills. Now this works are transfered to the new incorporated company of East Siberian Cast Iron, Iron Making and Mechanical Works, which has received from the government an order for supplying about 100,000 tons of rails and other railroad accessories.

The Nicolaicosk Works possess a sufficient stock of ore, and will use for fuel charcoal, which is to be prepared in the neighboring forests.

The company has reconstructed two old blast furnaces, and has begun to build two new blast furnaces, each with the production of 30 tons daily; it has reconstructed the old Siemens-Martin furnace, and will build a new one; it has ordered abroad a new rail rolling mill, which will be ready this spring, and then the manufacture of rails in Siberia for the Siberian Railroad will begin.

It is expected that the two already existing blast furnaces will yield 10,000 tons of cast iron, and that the order of the government will begin to be executed this year.

The greatest difficulty in operating this plant is the want of workmen, the country being very sparsely settled. The food for workmen must also be carried from Tekoutsk. It was expected that a party of 500 to 600 exiles and prisoners would be commissioned for the Nicolaicosk works, but only 200 men have been carried there; the balance will be forwarded this year.

The country crossed by the Central Siberian Railroad is not so level. The ruling gradient on its first 360 miles is 0.008 (or 0.8 per cent.), and on the remaining part of line 0.015 (1.5 per cent.), and the minimum radius of curved line is 1,050 feet.

(To be Continued.)

The Shops of the Q & C Company.

Some time ago the growing business of the Q & C Company, of Chicago, made it necessary for them to secure more shop space, and their manufacturing plant, which had been located in the city, was moved to Chicago Heights, a suburb some miles out on the Chicago & Eastern Illinois road. A recent visit to the new plant by a representative of this journal proved to be an interesting one.

The building is of brick, 210 feet long by 54 feet wide and two stories high, thus giving an available floor space of over 20,000 square feet, which is ample for present requirements. The office of the Superintendent, Mr. W. W. Holmes, is on the first floor, and the drawing office and pattern-room occupy a portion of the second floor. The building is well lighted throughout, and is heated by a hot-blast system put in by Messrs. Bailey & Sons, of Milwaukee.

There are many plants of this size in which, if we would judge from appearances, it is not considered worth while to strive for those economies in steam generation that are obtainable in comparatively large power plants, but this is not the spirit in which things are managed in these shops. The power is supplied by a good Porter-Allen engine and steam is generated by a boiler having a down-draft furnace, with which excellent results are obtained. The condensation from the heating system is returned to the boiler, and, in fact, nothing that can be saved is wasted. The coal is delivered in car-loads at the boiler room and with the down-draft furnace screenings at 90 cents per ton are burned successfully. The shop also has its own electric light plant.

The largest machines built in this shop are the company's cold metal sawing machines, which are made in various sizes and styles, ranging from small portable affairs up to power machines weighing over 16,000 pounds. We have in the past illustrated several of these saws and will soon publish engravings of others.

The company recently shipped to the Ironton Structural Steel Company, of Duluth, a saw capable of cutting off I-beams 30 and 40 inches deep, and the 16,000-pound machines mentioned above have gone to steel foundries, where they are used in cutting off gates from steel castings. The great power of the machines can be appreciated from the fact that one of them cut through a piece of solid crucible steel 15 inches in diameter in the almost incredibly short time of 28 minutes.

The company can boast of nearly 300,000 freight cars equipped with Q & C doors. Naturally the car door work forms a large portion of the total output of these shops, and up-to-date machinery is employed in the manufacture of such parts as need machine work.

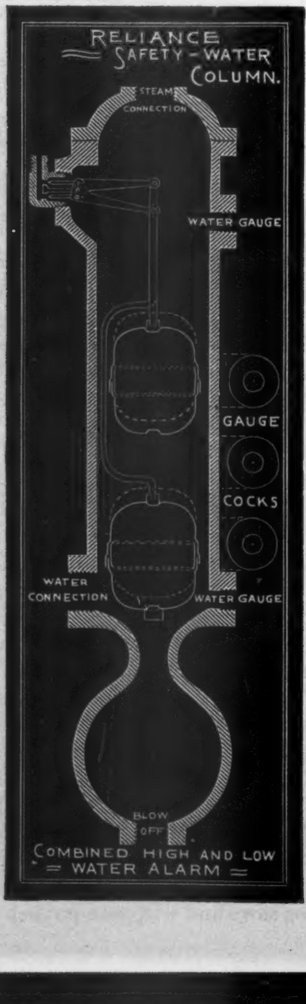
An excellent change has recently been made in the pressed steel brakeshoe key made by the company. It was formally U-shaped in section, but for some inches in middle of its length it is now made with the section in the form of a hollow square. This is accomplished by giving additional width to the sheet steel blank at that point, and by a second flanging movement bending it down to form the fourth side of the hollow square. The advantage of this change is that where the key bears against the head and shoe it presents a bearing for its full width, whereas formerly it offered on side only the two edges of the plate from which the key was made.

The McKee brake slack adjuster made by this company has been described in these columns. It has operated with success under very severe conditions, and the company is sparing no pairs to make it reliable in every respect. They are now putting a case over the ratchet and screw mechanism, and also constructing the pawl so that it does not have to be raised when an inspector wants to let out the adjuster to put in new shoes. One could not ask for a more compact device than this adjuster now is. There is a good prospect of the adjuster being adopted as standard by a large and important road in the very near future.

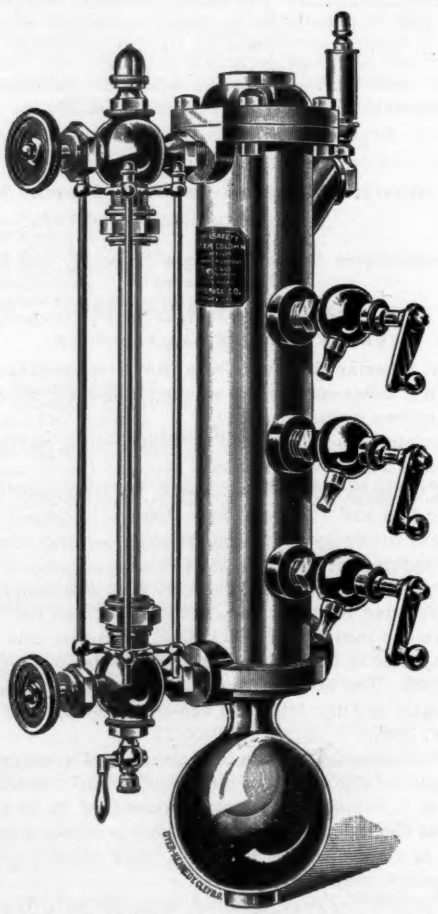
The Reliance Safety Water Columns.

The safety water columns made by the Reliance Gauge Company, of Cleveland, O., are of two kinds, those which whistle only when the water in the boiler reaches the lower limits of safety, and those which whistle before the water either gets so low as to burn the boiler or so high as to be in danger of flooding the engine. Sections of both of these columns are shown herewith, together with an exterior view.

The columns are designed to form a check upon the operations of the fireman and to prevent carelessness on his part. If he is negligent and permits the water level to fluctuate up and down he is certainly not doing his work in a manner that will keep the coal bills down to a minimum. Furthermore, his inattention may at any time result in something more serious than waste of coal—there may be a burning of the boiler or an explosion due to low water, or a breaking down of the engine from the presence in the cylinders of water carried over from the boiler. The alarms on these safety columns are not provided for those in the boiler-room, but to give information to the superiors of the fireman as to the way in which the latter does his work. The presence of these alarms, however, and the knowledge that carelessness on his part will certainly be known by others, tends to make the fireman careful. Where he is not sufficiently self-respecting to keep the proper water level under such checks as these, there is abundant proof of his neglect and a chance to properly discipline him. In justice to the fireman it should be said, however, that ordinarily he is as pleased with the safety water column as is his employer.



From the engravings it will be seen that the column is provided with one or two floats according to whether it is to give an alarm



The Reliance Water Column.

for low water or for both low and high water. The floats are of superior quality, patented by the company, and are solderless. Their reliability can be inferred from the fact that of the thousands put in use in the last 10 years less than two per cent. have failed in any way. These floats do not move with every change of water level, and hence do not wear themselves out rubbing on the sides of the column.

One of the great enemies to reliability of any device about a boiler is sediment. These columns have sediment chambers at the bottom to which blow-offs are attached, and not only is the whistle protected from the presence of sediment, but likewise the gage-cocks and water glass. The whistle connection is the shortest possible.

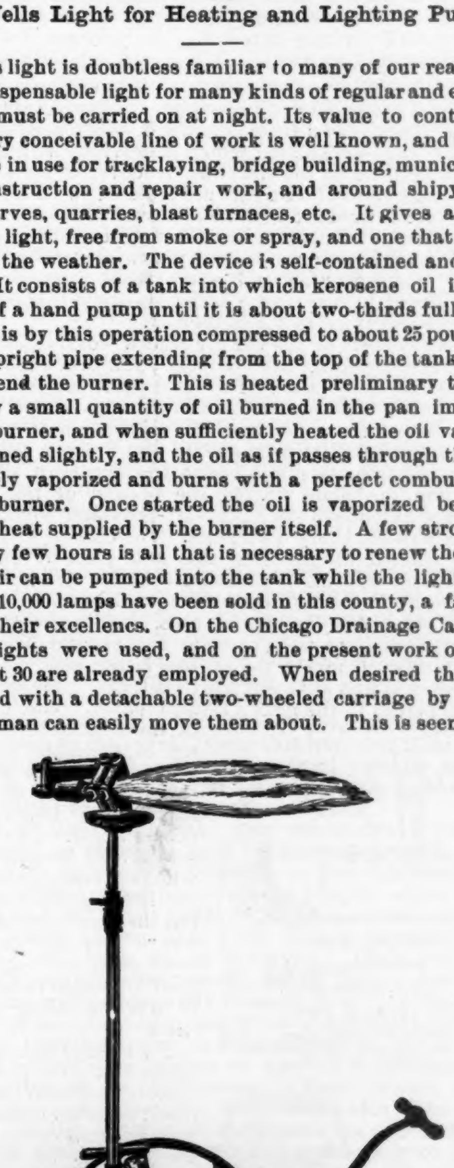
An entire absence of objectionable features is claimed for these safety columns. They have no leaky floats, no mud-catching valves or mud chamber between the valves and the whistle, no adjustable "knockers" to become loose or to be adjusted in a way to render the appliance inoperative. The floats do not rise and fall with every movement of the water. There are no complicated parts to corrode or stick, and there is nothing to adjust or readjust.

There are no fusible plugs to be rendered nonfusible by heat, or by becoming coated with scale or sediment. There are no expansion tubes, which fail chiefly on account of the interference of sediment and consequent failure of the water to run out of the tube and admit the steam necessary to expand it. Furthermore, the workmanship is of the very best.

From what we have already said it should be clear that these safety columns are not merely safeguards for the purpose of preventing boiler explosions; their purpose is to prolong the life of the boilers, reduce the cost of maintenance, lessen the waste of fuel and obviate stoppage, and to protect life and property, all of which is accomplished by causing the water to be carried steadily at the proper level. Boilers last longer and it costs less to keep them in repair if the water is carried steadily at the proper level. It is also easier to maintain steady steam pressure, and less fuel is wasted. Owing to the low cost of these appliances, the saving resulting from their use is an excellent return on the investment.

The Wells Light for Heating and Lighting Purposes.

The Wells light is doubtless familiar to many of our readers as an almost indispensable light for many kinds of regular and emergency work that must be carried on at night. Its value to contractors in almost every conceivable line of work is well known, and thousands of them are in use for tracklaying, bridge building, municipal work, general construction and repair work, and around shipyards, drydocks, wharves, quarries, blast furnaces, etc. It gives a powerful clear white light, free from smoke or spray, and one that cannot be affected by the weather. The device is self-contained and perfectly portable. It consists of a tank into which kerosene oil is pumped by means of a hand pump until it is about two-thirds full. The air in the tank is by this operation compressed to about 25 pounds' pressure. An upright pipe extending from the top of the tank carries at its upper end the burner. This is heated preliminary to starting the light by a small quantity of oil burned in the pan immediately under the burner, and when sufficiently heated the oil valve at the tank is opened slightly, and the oil as if passes through the burner is completely vaporized and burns with a perfect combustion outside of the burner. Once started the oil is vaporized before combustion by heat supplied by the burner itself. A few strokes of the pump every few hours is all that is necessary to renew the pressure, and oil or air can be pumped into the tank while the light is burning. Over 10,000 lamps have been sold in this county, a fact which attests to their excellence. On the Chicago Drainage Canal about 60 Wells lights were used, and on the present work on the Erie Canal about 30 are already employed. When desired these lights are provided with a detachable two-wheeled carriage by means of which one man can easily move them about. This is seen in Fig. 1,



The Wells Light.—Fig. 1.

which shows a No. 3 light which is of 2,000 candle-power, has a flame 30 inches long, a tank 18 inches by 24 inches, and uses only one gallon of oil per hour. It will burn for 14 hours without recharging. The great size of the flame prevents the casting of sharp shadows such as produced by an electric light, and which are so annoying.

While our readers may be familiar with this light as used for lighting purposes, we doubt if they have as fully considered its merits as a device for heating, particularly where the heating is to be confined to a small area. In railroad shops the use of the Wells burner for heating tires when setting or removing them is common, but there appears to be no good reason why these burners should not also be used for many repair jobs in machine shops, roundhouses, etc.

The Wells Light.—Fig. 2.

Locomotive frames that have been bent at points that would permit of straightening without removal can be heated with these burners, and even when a frame is removed for straightening, the advantage of heating it locally only is obtained by the use of these burners. In boiler work also it is handy.

Water-works companies and contractors have recently found a use for it in repairing water mains.

To remove sections of pipe it is necessary to melt the lead in the joint, and this has heretofore been done by crude means that has consumed much time and invariably resulted in the loss of the lead. Now Wells burners are used and a receptacle placed under the joint to catch the lead. The intense heat concentrated on the lead melts it quickly, and a great saving of time and lead results. So successful has been this application of the device that many orders are being received for outfits adapted to this work.

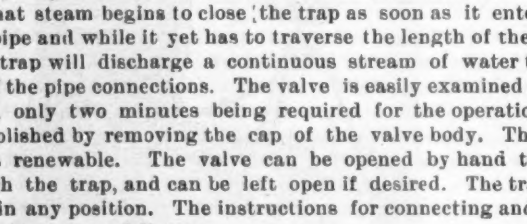
Around shipyards and drydocks the Wells light is frequently used for heating purposes, particularly in repair work. Something over a year ago a Clyde Line steamer grounded in New York Bay and bent several of her plates. She was taken to a dock, a Wells outfit for heating was purchased, and with it the plates were heated and straightened, the ship going out again the next day.

The Wells Light Manufacturing Company makes the arrangement for heating (which can also be used for lighting) shown in Fig. 2. The burner can be swung up to a wooden pole or beam, or lowered below the level of the lamp, and is thus rendered practically independent of the tank. For use in drydocks or up and down the sides of a ship during building, it is invaluable.

The company is prepared to adapt the light to any special heating purpose and to provide the mechanism that may be needed in such cases in addition to the tank, burner, etc. The Wells light is made by the Wells Light Manufacturing Company, Edward Robinson, sole proprietor, 44 and 46 Washington street, New York City.

The Geipel Steam Trap.

We illustrate herewith a new steam trap placed on the market by the firm of Thorpe, Platt & Company, 97 Cedar Street, New York City, and which possesses many merits. It has no floats, no faced joints, no internal working parts of any kind, is compact and attachable in almost any part of a boiler or engine-room. Fig. 1 is an outside view of the trap, while Fig. 2 is a line drawing showing its construction. It consists of a cast-iron casing into one end of which is secured an iron and a brass pipe. The other ends of these pipes are screwed into a valve body as shown, which is not attached to the casing, but is supported by the pipes only. The brass pipe is the inlet pipe and the iron pipe the outlet. If both pipes are at the same temperature the valve body is at the height shown in Fig. 2 and water seeking an escape would raise the valve and pass through the iron pipe. But if steam enters the brass pipe, it immediately expands it and by so doing raises the valve body, the spindle of the valve being forced against the adjustable lever shown and thus firmly held to its seat. The escape of steam is thus shut off and with remarkable promptness—so quickly in fact that the action of the trap cannot be timed by a stop watch.

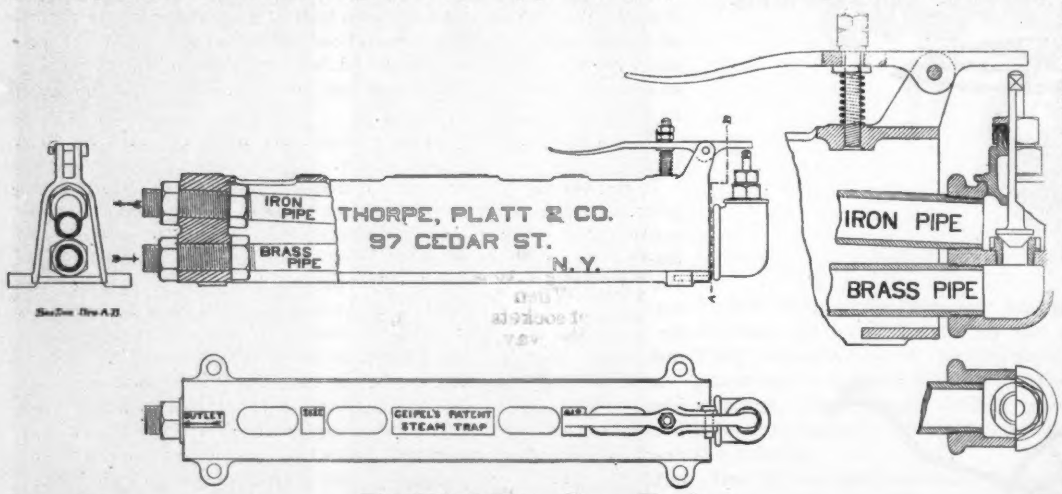


The Geipel Steam Trap.—Fig. 1.

This rapidity of action can doubtless be attributed in part to the fact that steam begins to close the trap as soon as it enters the brass pipe and while it yet has to traverse the length of the latter.

This trap will discharge a continuous stream of water the full bore of the pipe connections. The valve is easily examined and replaced, only two minutes being required for the operation; it is accomplished by removing the cap of the valve body. The valve seat is renewable. The valve can be opened by hand to blow through the trap, and can be left open if desired. The trap will work in any position. The instructions for connecting and working the trap are as follows:

Connect the lower or brass pipe, which is the inlet, with the steam pipe or vessel to be drained by at least 3 feet of pipe, in which a valve or cock should be inserted. The top or iron pipe is the outlet, and should be connected with the drain, or it may discharge into a tank at any height within the head equivalent to the pressure of the steam. In the latter case a non-return valve is preferable on the outlet to prevent the water returning into the steam pipe when cold.



The Geipel Steam Trap.—Fig. 2.

When the trap discharges into a sealed drain it is an advantage to have a three-way cock on the outlet, one branch being arranged to deliver to the atmosphere in order that the working of the trap may be inspected. To blow through press down the lever. To adjust the trap, screw down the nut on the lever until steam blows through, then slack back until steam is shut off and lock the nut. The trap will then only discharge water. When fixing to new steam pipes it is well to blow through the connection to the trap before the latter is fixed, in order to clear away any dirt in the pipes. If any steam should blow through, the valve should be examined, which may be done by unscrewing the cover.

The trap is specially adapted for marine and electric light work, and for steam pressures from 135 to 300 pounds per square inch. To marine engineers it presents several special advantages in addition to those already enumerated. Its working can be seen from the outside and it is not necessary to take off covers or break joints; it is very light; its construction is such that it may be conveniently fixed on the engine columns or bulkheads, vertically or otherwise, and will drain the main steam pipe, the valve casings, the steam jackets or branch pipes to auxiliary engines, keeping these important parts clear of water without loss of dry steam. In so doing there is not only a distinct economy in steam, but also in packing, which is found to last longer when this steam trap is used. An additional advantage is that less water is lost through the glands, "the fresh water make up" thus being less. This has been found in practice an important economy. This trap has met with most extraordinary success in Europe, and is used by the British Admiralty for high pressure steam and also in public buildings where heating with exhaust steam is employed.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—XI.

BY OSCAR ANTZ.

(*Concluded f om page 64.*)

BOX CARS.

Box cars are adapted for carrying almost all kinds of material which is not too large to pass through the doors and which does not have to be protected against changes of temperature.

A box car consists of a framed house or box placed on the floor-frame which has been shown, which is provided with doors on the sides and sometimes on the ends and is covered by a tight roof. The usual dimensions of box cars are from 34 to 36 feet long over end sills, 8 feet 6 inches to 9 feet wide over side sills and about 7 feet high in the clear inside. The framing consists of a series of posts and braces between the roof plates and floor frame, tied together by means of rods, and while there are many different styles of framing in use, there is a tendency toward one style which will be described in a general way.

At the four corners of the car are placed corner-posts; at each side of the door openings are doorposts, and over each end of the body bolsters are body-posts. The space between the latter posts and the doorposts is divided into two or three parts by one or two other body-posts. From the foot of each body-post, over the bolster, braces extend upward, one to the corner made by the corner-post and side plate, and one to the corner of the adjacent body-post and the plate. From the bottom of the latter post another brace extends to the next body-post and so on, there being a brace between every two posts. The corner and door posts are usually framed into the side sills and plate by mortices and tenons, the other body posts and braces are set into castings which are framed into the timbers by means of dowels. The plate and sills are tied together by means of rods, usually one to each post, excepting, perhaps, the posts over the bolster, and diagonal brace rods are run down from the top of the latter post to the bottom of the corner-post and adjacent body-post, and sometimes another brace rod is placed in the next adjacent panel. The nuts on top of these rods are let into the top of the plate, and washers are put under the nuts of all the rods, those on the brace rods being beveled to the proper angle. The brace rods are omitted by some builders, who rely solely on the tie-rods for holding up the framing, but the good results obtained where they are used and the small additional cost of putting them in would certainly seem to warrant their use in all cases.

The ends of cars are usually framed of two posts, spaced equally between the corner-posts, and two braces running from the tops of these posts to the bottoms of the corner-posts. Sometimes four vertical posts without any braces are substituted. A vertical tie-rod from end plate to end sill is placed near each post. The corners of the car body are fastened together by short tie-rods, and further by corner irons, inside as well as outside, bolts passing through both angles.

The side and end plates form the upper corners of the car body, and into them are framed the side and end framing and the framing of the roof. The end-plate is straight on the bottom, the upper side being beveled both ways to the shape of the roof; it is framed into the side plated by mortice and tenon, and secured by a horizontal tie-rod. About midway between the plate and sill are placed the side and end girths, which are cut out for each post and brace, and are lipped over door and corner posts.

The outside of the car is covered with matched sheathing, $\frac{7}{8}$-

inch thick, usually about 5 inches wide, beaded or grooved at the joint between the separate boards, with a similar bead or groove through the center of the board. The sheathing runs from the top of plate to the bottom of end sill, and is nailed to these timbers and to each frame, brace and girth which it crosses. The door-posts are rabbeted out for the sheathing, but the corner-posts are usually enclosed by it. The inside of the car is generally sheathed horizontally, as far as the girth, the upper part of the framing being exposed, though sometimes the entire inside is sheathed. The inside sheathing should not reach all the way to the floor, and a triangular strip of wood should be placed in the corner between outside sheathing and the floor, to facilitate the removal of grain or other fine material which is apt to work its way behind the inside sheathing when loaded in bulk form. The top end of the outside sheathing is covered by the frieze boards, a narrow piece of wood nailed to the plate and to this is fastened the eave moulding.

ROOFS.

There are quite a number of different kinds of roofs in use on box cars, but the framing of most of them is about the same, and consists of a number of carlines, extending from side to side of the car, and mortised into the side-plates. The top is beveled to the slope of the roof while the bottom is straight. The carlines are tied to the plate by means of tie rods extending across the car through both plates, though sometimes they run only from the purlines to the plates. The ridgepole is mortised into the carlines and end plates at the center on top side, and the purlines are spaced between the ridgepole and side plates, usually one or two on each side of the car.

One of the earliest roofs in use, and one which is sometimes still used on large cars, is the so-called double board roof, which is made of two layers of boards, all of one width, the two layers breaking joints with one another; grooves are usually cut into the boards to conduct any water which gets on the roof or between the two layers, down to the eaves. This roof gives considerable trouble on account of the nails which fasten it breaking off, whereby water gets into the boards and causes decay.

Quite a common roof is the tin roof, consisting of sheets of tin soldered together and fastened upon a single layer of roof boards, which usually run lengthwise of the car. This roof is liable to break at the joints of the sheets, and unless the tin is of the very best quality it will rust very soon from the effects of the gases from the locomotive. Other roofs are made of canvas, tarred paper or other material, placed over a single layer of boards or between two layers of boards, and all of these have their good and bad points.

One of the most extensively used roofs, which keeps in good condition for a long time, but is somewhat more costly to put on than some of the others, consists of sheets of galvanized iron, rolled in the form of a channel, which extend across the car, their edges being held in grooves cut into sub-carlines fastened to the purlines. These sub-carlines are covered with caps of galvanized iron screwed fast to them, which lap over and into the channeled plates, conducting any water which gets on them through these to the eaves. Over this iron roof is laid a wooden one, which protects the one under it from damage by trainmen walking on it. When well put together with good-sized screws this roof ought to last as long as the car itself.

On top of the roof, usually over the center, is placed a horizontal board, or several boards, making up a width of about 24 inches, which serves the trainmen to pass from one end of the car to the other. This board should project about 6 inches beyond the end of the car body, bringing the adjacent ends of the running boards of two cars close enough together to enable trainmen to step from one to the othet. These running boards are usually secured to saddles cut out on their lower edge to the shape of the roof and securely fastened to it. At the ends of the car short pieces of running boards are sometimes located between the main running board and the sides of the car, to enable the trainmen to reach the ladders to descend to the ground without having to step on the roof proper. These ladders are usually made of iron rungs fastened either to wooden sides or direct to the car; in the latter case their ends are offset so as to bring them away from the side of the car sufficiently to give a foothold. At the top of the ladder, on the roof, is placed a short piece of hand-railing or guard, to assist trainmen to mount the roof from the ladder. Two ladders are usually provided, placed at diagonally opposite corners, and they are either put on the end or the side of the car, close to the corner. On both sides of the car, at each end, are placed steps made of flat iron in U-shape; extending below the side sill, to assist trainmen to mount the ladders or pass over the platforms of the cars. Handholds or grabirons are provided at convenient places to assist trainmen in passing along or over the cars, or when coupling or uncoupling while cars are in motion.

The brakeshaft usually extends over the roof of the car, on which the brakeman stands while using it, although sometimes a step is arranged for this purpose on the end of the car slightly below the roof.

DOORS.

While the number of different kinds of box-car doors is very large, it can be said that as yet no really satisfactory one has been devised. Some of the important points which should be found in a good door are simplicity and ease of operation, security against water, dust and cinders, and against theft, and security of fastening.

Security against water and other detrimental substances is obtained to some degree by having the door fit in a beveled opening, making it flush with the outside sheathing when closed. This style of door is, however, difficult to open when it is fitted close enough to obtain the security desired.

A very simple door can hardly be obtained if the other points mentioned are to be considered, but is approached somewhat closer in some of the doors which close by lapping over the door-posts.

Doors should be hung from a track fastened to the side of the car above the door, and for ease of operation the hangers should be provided with sheave wheels. To exclude water, cinders, etc., there should be a lapped joint at each of the four sides of the door. Theft of goods in a car is often accomplished by prying the door away from the side of the car sufficiently to remove them, and this is prevented by providing brackets on the side sill of the car which will not allow the door to be pried away from the car, an improved form of this bracket being arranged so that it cannot be removed while the door is closed. One of the most important points to be considered in car doors is to have them secure against being displaced, even if certain parts should become broken, so that the door will not swing away from the car and possibly damage cars on the adjacent track. This is accomplished in a recently introduced door in which plates of iron on the door when closed lap behind other plates fastened to the car.

The door proper is sometimes made as a regular framed structure, with panels set in rabbeted posts and rails, but in most cases the doors are simply made of sheathing nailed to a plain frame of pieces of boards, lapping or butting at the corners, and sometimes provided with two braces to keep them square. The doors are provided with an attachment for holding them closed, consisting of a hasp and staple and some kind of a pin through which the wire seal is passed after the car is loaded. A handle is provided for moving the door and a stop is placed on the side of the car to prevent the door from being moved off of its supports.

Box cars are sometimes provided with doors in the ends, through which long material is loaded which cannot be placed in the car through the side doors. These end doors are usually of the same pattern as those on the sides, but always considerably smaller.

It is often desirable to expose certain ladings, such as fruit and vegetables, to a change of air, and many cars, especially in the warmer parts of the country, are provided for this purpose with screen doors in addition to the solid ones, either of which can be placed before the door, opening at will. The screen doors are usually made of an ordinary frame covered with some kind of metal screen, or iron bars are inserted in the frame vertically, leaving a small space between them.

The end doors, with which such cars are usually provided, are also fitted with screen doors, and additional ventilators are often provided through the sheathing of the car.

Grain of different kinds is usually carried in box cars in bulk, and to confine it in the car it is necessary to provide some way of closing up the door pening from the inside, as the regular outside-hung door would not be tight with the pressure against it from the inside. Boards nailed to the inside of the doorposts, to the height of the lading would be sufficient, and are sometimes used, but generally the cars are provided with permanent grain doors, which are attached to the car and remain with it, although they are not considered as a necessary part of the car. Grain doors are usually made of matched boards nailed to a frame, and are long enough to lap over both doorposts, the height being about 3 feet. When in use the doors are held against the posts, by means of sockets or hooks, and when not in use they are stored out of the way, either on the side of the car or hung from the roof, permanent attachments in the shape of rods, levers or chains being provided to prevent the door from being lost.

FURNITURE CARS.

Box cars of the ordinary sizes cannot be loaded to their full carrying capacity with certain kinds of material which takes up considerable space for its weight, such as furniture, carriages, hay, etc., and this has led to the building of box cars of the usual capacity of 60,000 pounds, but of much larger dimensions than usual, which cars are variously called furniture, carriage, buggy or hay cars. The extreme limits to which these large cars should be built is a question which at present is causing considerable discussion, the traffic departments calling for even larger cars than those already built, while for the sake of strength and weight the present sizes should not be exceeded. The cross-section of the cars is limited by the clearance of bridges and the other structures along the line of the roads, and many cars in existance to-day will not pass over certain roads. The length of most of the existing furniture cars is about 40 feet, although some 50 feet long and a

few 60 feet long have been built; the width runs from 9 to 10 feet over side sills, and the height from 8 to 9 feet inside in the clear.

These cars do not differ to any great extent in their construction from ordinary box cars, the framing being very much alike, additional posts and braces being put in on account of the greater length of the cars. To get the increased height inside without having the height over all beyond the limits for clearance the floor has to be placed nearer the rail, which necessitates a change in the draft gear, this being placed usually between the center sills, no regular draft timbers being used, and the end sill is made considerably deeper to allow the drawbar to pass through it. The door opening is also made considerably larger, and grain doors are usually omitted.

On account of the low floor, the trucks have to be lowered correspondingly, which is sometimes done by changing the offset of the arch bars from that of the regular cars, though in some cases specially designed trucks are required.

Even with the large side doors, it is sometimes not possible to get large carriages through them into the car, and for this purpose large folding doors are provided in one or both ends of some cars made in two parts, hinged at the sills and opening outward.

HEATER AND REFRIGERATOR CARS.

As has been stated, ordinary box cars do not protect the lading against changes in temperature, and perishable material has to be transported in cars built for this special purpose.

For protection against cold, which is necessary during winter weather in transporting fruit and vegetables, so-called heater cars are provided. These consist of box cars of which the sides are made double, and often provided with air spaces, felt or other non-conducting substances between the inner and outer sheathing. On top of the car is a funnel, through which air is blown by the motion of the train into a pipe which conducts it to a stove in a box suspended from the bottom of the car, where it is heated, and it then passes to the interior of the car. Kerosene is used in the stove as fuel, a tank being provided from which the oil flows to the stove automatically as needed. The heat is regulated automatically by means of the expansion and contraction of metal rods, and while the temperature maintained is not very high, it is sufficient to prevent the lading from being frozen.

Fresh meats and other commodities which must be kept at a low temperature, are transported in refrigerator cars. These also consist of box cars whose walls are made of two or three thicknesses of boards, separated by air spaces or non-conducting material, and provided with tanks for holding the refrigerating medium, which is usually ice or ice and salt.

While the general principle of these cars is about the same, there are quite a number of different systems of refrigeration which differ in their details and each of them possesses, no doubt, some merit of its own. The tanks are usually arranged in such a manner, in connection with partitions in the car, that a current of air is created, which passes over the ice and then into the body of the car. In some systems a current is created by the motion of the train. The tanks are made of galvanized iron and are provided with drip-pipes, which are sealed against air entering them from the outside by a small pan filled with water, into which the lower end of the drip-pipe enters.

The doors of refrigerator cars are made as thick as the sides of the car and are insulated in the same way; they are usually made to fold, being hung on hinges, and the edges are made on a level with several offsets, the door opening being arranged in a corresponding manner, and canvas is often used to make a tight joint. Doors are provided in the roof for filling the tanks with ice.

Material requiring the use of refrigerator cars is transported usually only in one direction, toward the coast, and when box cars are in demand for lading destined in the opposite direction, some roads make it a practice to remove the ice, by means of steam, from the cars, after the perishable stuff has been unloaded, and after thoroughly drying the car, it is used in regular service going to its starting point.

STOCK CARS.

In the transportation of live stock, provision must be made to admit light and air to the cars and as almost all stock, with the exception, perhaps, of certain kinds of horses, will stand a moderate amount of cold without suffering, little if any protection is given against the weather.

Stock cars can be described as box cars without the solid inside and outside sheathing, this being replaced by slats of wood with open spaces between them. The framing of stock car bodies varies perhaps more than that of any other kind of car and there does not seem to be any particular style which might be selected as being most in favor. Posts are used, of course, in the framing and there are quite a number of ways of fastening these to the floor frame. Some are set in stake pockets on the side sill, some are merely bolted to it; others are set on the side sill, being mortised into it; others again are set into cast pockets, which are framed into the top of the side sill. Braces are used on some cars, while some builders put in a large number of posts and depend on the slats for bracing of the body, or put in short braces between the posts, extending up only two or three feet, which is necessary with some kinds of feeding and watering attachments. Probably one of the best systems of framing is similar to that of the box car which has been described, consisting of corner and door posts, body-posts over bolster and one or two more between this and the door post; braces running from the bottom of the bolster body-post to each adjacent post and other braces from the bottom of the other body-posts to the top of the next one toward the center of the car. The ends are framed with posts and braces similar to those on box cars and brace and tie rods are used in the same manner as in those cars.

The bottom of the posts and braces are set in pocket casting on top of the side sill, high enough to project above the floor; the bottoms of the pockets have holes cast in them to the outer edge to carry off any liquid matters which might find their way from the car into the pockets.

Horizontal slats are nailed to the posts with a space of 2 or 2½ inches between them, the slats being generally about 5 to 6 inches wide, although often the lower one or two boards are made wider. Both sides and ends of the car usually have these slats, though recently the ends of many cars have been sheathed up solid to afford some protection against the weather. The top part of the sides is sometimes made solid far enough down to allow for the name and number of the car, or if this is not done, the lettering is placed on boards which are fastened to the outside of the posts.

The doors of stock cars are usually placed in the center of the sides, though sometimes they are found near the ends; they are made of an open frame, which is provided with vertical or horizontal slats of iron rods, and are hung from a rail at the top of the door opening, the lower part being guided by a bar of iron fastened to the door and turned up on the inside of the side-sill, or secured when the door is closed by some sort of a hasp and staple fastening.

End doors are often put on stock cars to be used for loading long material, such as lumber, rail, etc., for which these cars are sometimes utilized, especially on the return trip after having been used for a load of stock. Across the doorways on the inside of the car, a bar is often placed to prevent the stock from pressing against the door and loosening it from its fastenings.

To utilize space in transporting small animals, such as hogs and sheep, an additional floor is placed in the car, dividing the vertical space in two, this floor being often put in temporarily, though some cars are built with a permanent double deck. In the latter case, each deck has its own independent doors, the lower rail of the top one also serving as top rail of the bottom door.

The roofs of stock cars need not necessarily be very tight and as a rule only single or double layers of boards are used. The attachments for the safety of trainmen are the same as those decribed for box cars.

The feeding and watering of stock in transit is generally done by driving the animals into pens at certain stations for that purpose. Many contrivances have, however, been introduced for feeding and watering without unloading them. Hayracks are placed in some cars along the top of the sides which are made of a skeleton frame hinged to the side of the car at the bottom and held in place when open by chains; when not in use the frames are fastened up to the side of the car. On other cars boxes are placed on the roof along the sides for the same purpose of holding hay, the bottom of the boxes being made of slats or bars.

Troughs for watering or feeding are placed on the sides of the car, two or three feet up, or on or near the floor, of double-deck cars, some of which can be swung out of the way when not in use by means of rods and levers leading to the side or top of the car. Pipes are often provided to which a hose can be attached for supplying water, or the water is brought through them from a tank in the roof of the car.

For transporting blooded horses and cattle a better class of cars is usually used, which are sheathed inside and out for at least part of the way up, and are often provided with windows whereby the car can be closed entirely. Stationary or movable stalls, feeding and watering appliances and other conveniences are also provided.

In the transportation of live poultry somewhat larger cars are used, which are fitted up with boxes or crates in tiers, and the sides of which are closed in by wire netting; some of the floors are movable, so as to allow for transporting small and large-sized fowl, and troughs for feeding and watering are also provided.

The capacity of stock cars is seldom as high as 60,000 pounds, as a car of the usual size could not be loaded with that weight of cattle, and the trucks are therefore generally built lighter; and as an easy motion is very desirable with the class of freight carried, the trucks are generally built with swinging bolsters and often provided with elliptic springs.

TANK CARS.

For the transportation of liquids in bulk, such as oils of all kinds, acids, molasses, syrups, etc., flat cars are used on which is placed a cylindrical iron tank, lying horizontally; provided at its center with a dome, in the top of which is a manhole through

which the tank is filled; a connection and valve at the bottom being arranged for emptying it. The heads of the tank are dished outward. The tank rests on longitudinal subsills and is fastened to the cars by means of iron straps passing over the tank with bolt ends passing through the floor frame. Handrails of iron pipe are provided along the sides of the car for the protection of trainmen.

Compound Compressed-Air Locomotives.

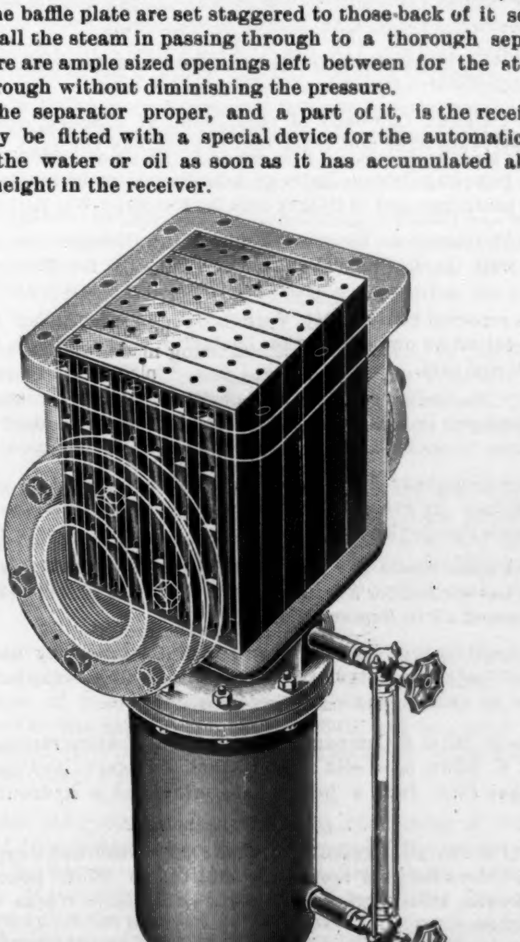
The Baldwin Locomotive Works are building a compound compressed air locomotive to be used at the Alaska Colliery of the Philadelphia & Reading Coal and Iron Company. The air will be compressed by a three-stage Norwalk compressor. A "standard line" pipe 2,680 feet long and guaranteed to stand a pressure of 1,000 pounds per square inch will extend through the mine and serve as a reservoir for the storage tanks on the locomotive, and provision will be made so that these may be charged from the long pipe in two or more places in the mine. The locomotive cylinders are 5 and 8 inches by 12 inches, and the valves, ports and connections are of the same general type as are in use on the Vauclain compound locomotives. The driving wheels will be 24 inches in diameter, wheel base 4 feet 6 inches, and the track gage 3 feet 8 inches. The air will be stored at a pressure of 600 pounds, in three reservoirs having a total capacity of 170 cubic feet. The working pressure of the air in the high-pressure cylinder will be 200 pounds, and the cut-off will take place at one-half stroke. The height will be 5 feet 3 inches, width 6 feet, length over all 16 feet, and the distance between drivers 4 feet 6 inches. No reheater of any kind will be used.—Railroad Gazette.

Bundy Steam and Oil Separator.

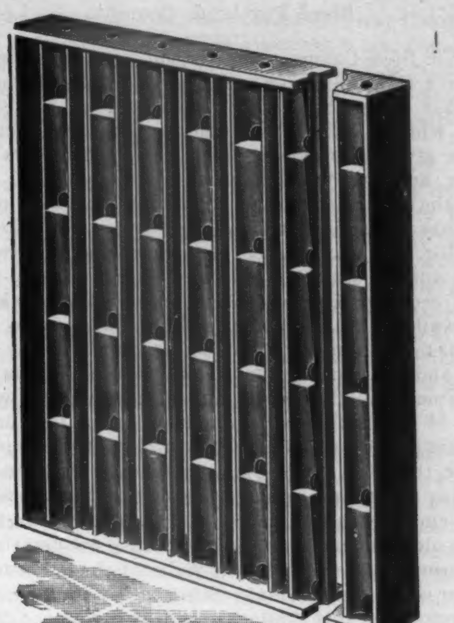
Different natural laws have been employed by separator manufacturers to remove water from live steam and oil from exhaust steam. Both gravity and centrifugal motion have been used, and now another force has been employed, that of capillary attraction, used in the Bundy separator.

A series of baffle plates are placed directly across the steam passageway and at right angles to it. Each baffle has a number of upright tubes supplied with openings leading to a main duct or capillary which terminates in the receiver below. The upright tubes of one baffle plate are set staggered to those back of it so as to subject all the steam in passing through to a thorough separation. There are ample sized openings left between for the steam to pass through without diminishing the pressure.

Below the separator proper, and a part of it, is the receiver, which may be fitted with a special device for the automatic removal of the water or oil as soon as it has accumulated above a certain height in the receiver.



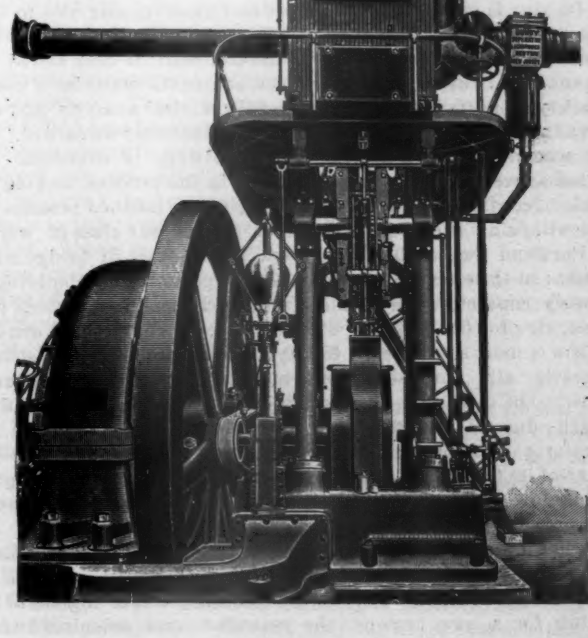
Bundy Steam and Oil Separator.



Baffle Plate of Bundy Separator.

The manufacturers in marketing this separator call attention to the natural well-known affinity water and oil have for following capillary pores, and claim that it is impossible for either to pass through or to be picked up again by the steam after it has once been separated. The water and oil follow the capillary passageways to the receiver and do not lose contact with the iron until delivered to the receiver from which there is no return circulation.

A late example of the application of the Bundy separator is here illustrated in the power-house of the New York and Brooklyn Bridge, where two ten (10) inch separators are in use. They were sold under a guarantee to deliver 99$\frac{85}{100}$ pure dry steam, and upon completion fulfilled the guarantee by passing the test imposed.



Ten-Inch Bundy Separator in Brooklyn Bridge Power-House.

The Bundy separators are made at the works of the A. A. Griffing Iron Company, Jersey City, N. J., with distributing offices in New York, Boston, Philadelphia and Chicago, and the specimen of condensation taken from exhaust steam after passing the Bundy oil separator shows absolutely no trace of oil.

Steel Portland Cement.

The Illinois Steel Company has for some time past been making at its North Chicago works a cement from blast-furnace slag, to which it has given the name "Steel Portland Cement." In a pamphlet which it has just issued, many testimonials to its merits are given by prominent architects, contractors and engineers. In an introductory some interesting facts are given regarding the material, from which we take the following:

Cement has been manufactured in Europe, mainly out of blast furnace slag, for many years, and there are repeated cases of important work in which it has stood as well as old-established brands of ordinary Portland cements placed alongside it. The great sea-wall on the Yorkshire coast, England, made entirely of this class of material more than ten years ago, is to-day in the best condition, and the same can be said of the foundations of the German Parliament buildings at Berlin, and of the great water-works conduit at St. Louis in our own country. This last undertaking alone necessitated over 500,000 barrels of cement to complete it.

Moreover, there is a striking similarity, both chemical and physical, between blast-furnace slag, the material from which Steel Portland Cement is chiefly made, and Puzzolanic lavas, the basis of the famous old Roman cements. These have not deteriorated during an exposure of 20 centuries, the walls of the Coliseum at Rome and of other celebrated buildings being to-day in first-class condition. On account of this similarity, and owing to the fact, shown by the tests, that Steel Portland Cement continually increases in strength with age, the Illinois Steel Company believes, with good reason, that its new product will, like the celebrated Roman cements, successfully stand the test of time.

The serious opposition which slag cement has hitherto encountered has been mainly due to two causes: First, its irregularity, and second, its slowness in setting, requiring from five to 24 hours to harden. The first difficulty arises chiefly from the fact that the slags of Europe are of themselves not at all uniform in composition. Furthermore, the slag-producers of Europe are seldom the cement manufacturers, and as the former consider the product of the latter merely of secondary importance, there is little effort made to produce a uniform slag, and consequently a uniform cement; the result is an article not to be depended upon, though at times of striking excellence.

With the Illinois Steel Company, however, the case is very different. Its slag is made from the purest and most regular ores in the world, and these ores are bought with special view to their qualifications for making regular slag of the composition best suited to the manufacture of cement. Moreover, before the material is used, each lot is submitted to the most careful chemical analysis, and all material not of the correct composition is absolutely discarded.

The second difficulty, that of slow setting, is overcome by patented as well as secret improvements in the process, making it possible to control the time of hardening of the finished product so that it will fulfill the requirements of almost any class of work. Steel Portland Cement has been used successfully in bridge construction; in the erection of large and important office buildings; for heavy concrete-work of all kinds, including foundations for engines, etc.; for fire-proofing of buildings; for lining mud drums of boilers (a most severe test); for laying brick and stone; in short, for nearly all purposes requiring a high-grade Portland cement. On account of its high tensile and compressive strength—due to the fineness to which it is ground—it is particularly well adapted for these classes of work, but also on account of its fineness it has comparatively low abrasive strength and therefore is not so well suited for granitoid work as are some other brands in the market.

Appreciating the fact that its reputation as a steel-producer must not be jeopardized by a failure of one of its other products and realizing its responsibility to the building trade in general in vouching for a new cement, the manufacturers submitted this material for several years to practical as well as theoretical tests before placing it upon the market. That Steel Portland Cement is to-day giving the very best satisfaction is evidenced by the high character of the testimonials received, and that the Illinois Steel Company has the greatest faith in the future of the product is shown conclusively by the fact that the capacity of the plant is being increased as rapidly as possible.

Among the claims made for this cement are the following: It is uniform in color and quality; it is ground to a greater degree of fineness than any other cement in the market; it shows great and constantly increasing strength when tested with sand or as used in practice; it contains absolutely no free lime, which is the common cause of cracking in Portland cements; it stands successfully the boiling test, a test for stability; it does not stain; the finished product presents a light-colored and smooth surface of uniform appearance; on account of the fineness to which it is ground it works easily under the trowel, consequently the masons all like it; it is submitted to careful chemical and physical tests before shipment; it constantly increases in strength with age, thereby insuring stability; it is sold at a price exceedingly low, considering its value; the manufacturers use it themselves in work of the greatest importance to the exclusion of all other high-grade cements.

The Croton Aqueduct Commission of the State of New York made a test of the cement in August, 1896, and the following table is a summary of the results:

Date when mixed.	Proportion by volume.		Per cent. of water to weight of cement.	Final setting time.		Temp. water used when mixing.	Temp. of room.	*Tensile strength in pounds per square inch.						
	Cement.	Sand.		Hours.	Minutes	Deg., Fahr.	Deg., Fahr.	24 hours.	7 days.	22 days.	3 months.	6 months.	9 months.	1 year.
1895.														
July 31..	1	0	28	2	26	56	62	149.6	270.6	363	436	404.4	511.8	575 8
July 31..	1	2	40	1	2	54	56	......	455.4	6[illegible]3.2	668.8	713 8	870	874.2

*All figures averages of ten (10) briquettes.

EQUIPMENT AND MANUFACTURING NOTES.

The Rio Grande Western has placed an order with the Ohio Falls Car Company for 200 cars.

The Mather Stock Car Company has contracted with the Ohio Falls Car Company for 50 live stock cars.

The Brooks Locomotive Works has shipped two 19 by 26 mogul engines to the Buffalo, St. Mary's & Southern.

The Wilmingtsn & Northern has placed an order with the Harlan & Hollingsworth Company for 200 gondola cars.

The Pullman Company is completing 12 sleeping cars for the Pennsylvania lines which are said to excel any yet built.

The Imperial Chinese Railway Administration is in the market for 10 passenger and 16 freight cars for the Sung-Wu Railway.

The Metropolitan Elevated Railroad of Chicago has placed an order with the Pullman Palace Car Company for 25 new trailer cars.

It is reported that the Mt. Vernon Car Manufacturing Company has received an order from the Louisville, Evansville & St. Louis for 100 coal cars.

Mr. C. J. Smith, receiver and general manager of the Oregon Improvement Company, has recommended the purchase of two new steamers, to cost $400,000.

The Schenectady Locomotive Works has received an order for five 20-inch by 26-inch 10-wheel passenger locomotives for the Southern Pacific Company.

The United States Air Refrigerating & Power Company, of New York, has applied for a franchise to lay pipes in the streets and sell compressed air in Newark, N. J.

On April 16 the Westinghouse Air-Brake Company passed the half-million mark in its brake freight shipments, having sold 503,519 sets of its automatic air-brakes for freight cars.

Bement, Miles & Company, through their Western representative, Mr. C. E. Billin, have sold to the Haskell & Barker Car Company, of Michigan City, Ind., a heavy axle lathe and a hydraulic wheel press.

The Pittsburgh, Bessemer & Lake Erie Railroad Company has placed orders for nine mogul locomotives of 167,000 pounds each. The Brooks, Pittsburgh and Baldwin Locomotive Works will each build three.

The through coaches of the Baltimore & Ohio Southwestern, which are used between the West and Baltimore & Ohio points, are to be painted royal blue, the new standard color of the Baltimore & Ohio.

The attachment for $12,000 placed upon the Rhode Island Locomotive Works, in November, by the Midvale Steel Company, has been discharged. It is reported that the works will resume operations in the near future.

The Pennsylvania Company is building at its Fort Wayne shops 200 gondola cars to fill vacant numbe rs in the equipment. The cars are to be equipped with Janney couplers, Westinghouse brakes and National brakebeams.

The Acme Journal Bearing Company, of Chicago, has recently been incorporated, with F. W. Thayer, President, and William Hamilton, Secretary and Treasurer. Its office and foundry is at 7 and 9 South Jefferson street.

Norcross Brothers, who secured the contract for excavation and foundations for the South Union Station, Boston, were on April 9th awarded a contract for the erection of the superstructure. The amount of the contract is almost $2,000,000.

A leading export firm placed a contract last month with the Brooks Locomotive Works for four locomotives for a private Japanese railroad company. The locomotives will weigh about 90,000 pounds each, and will have side tanks.

The Lake Shore & Michigan Southern is building five baggage cars at its Cleveland shop. The road has recently changed its standard passenger coach color from yellow to the Wagner standard. The striping and style of letters are also changed.

The Southwark Foundry and Machine Company, of Philadelphia, has secured an order from Russia for four large blast furnace blowing engines. The engines are to be of the vertical compound disconnected type, weighing upward of 1,180,000 pounds.

The Brooks Locomotive Works last month shipped to the Jefferson & Clearfield Coal & Iron Company a four-wheel saddle tank engine, with 8 by 12-inch cylinders for use at that company's coke ovens. The total weight of the engine is 23,000 pounds.

Cast steel trucks and body bolsters made by the Shickle, Harrison & Howard Iron Company will be used for 280 box cars for the National Linseed Oil Company, which are now nearing completion at the works of the Missouri Car and Foundry Company.

The Rand Drill Company has recently received contracts for compressors from the Cleveland Shipbuilding Company, Cleveland, O.; the Wolverine Copper Mining Company, of Michigan, and from the Ball Brothers Glass Manufacturing Company, Muncie, Ind.

The Westinghouse Electric and Manufacturing Company has been figuring on a contract to supply the electrical equipment for an underground railroad to be built in Johannesburg, Africa. It is reported that the concern has good prospeots for securing the contract.

The United States Wind Engine & Pump Company, of Batavia, Ill., has completed a 100-foot tower, carrying a 30-foot windmill, for furnishing water supply to the Buffalo & St. Mary's Railroad. They are also supplying the water cranes, etc. The water is pumped from an artesian well 250 feet deep.

The Morgan Engineering Company, of Alliance, O., has received a contract for three electric traveling cranes from Jones & Laughlins, Limited, to be placed in the American Iron and Steel Works of that concern in Pittsburgh. Two of them will have a span of 40 feet, and the third of 80 feet, and each is of 10 tons capacity.

The Pennsylvania Railroad has awarded to the B. Hillman Ship and Engine Building Company, of Philadelphia, a contract for a new ferryboat of the same type and size as the *St. Louis*, recently built by the same firm. The new boat will be named the *New Brunswick*. It will be put into service on the company's new Twenty-third Street Ferry in New York.

The asphalt car roofing manufactured by the Drake & Wiers Company, of Cleveland, O., has been in successful use for the past 15 years and is claimed to be the only genuine asphalt car roofing in the market. It is now in use on over 50,000 cars. The Drake & Wiers Company are the pioneers in this class of car roofs, and are the only manufacturers who are willing to give a 10 years' guarantee of their roofs.

Robert W. Hunt & Company, The Rookery, Chicago, have been given the inspection of the material and construction of the 21 locomotives purchased by the Mexican Central Railway Company from the Brooks Locomotive Works. This concern is also engaged upon the inspection of the material and construction of 50 cattle cars for the San Francisco & San Joaquin Valley Railway Company, and 180 freight cars for the Colorado Midland Railroad Company, both orders being at the Pullman Works.

The Ingersoll-Sergeant Drill Company has recently received orders from the Atchison, Topeka & Santa Fe system for two cross-compound duplex air compressors, one of which goes to the Galveston shops of the G., C. & S. F., and the other to the Albuquerque shops of the A. & P. The same firm has an order for a large Duplex air compressor from the Chicago, Indianapolis & Louisville Railway for its shops at Lafayette, Ind. Both the steam and air cylinders of this compressor will be cross compound, and proportioned for a steam and air pressure of 125 pounds. The capacity of this machine will be 900 cubic feet of free air per minute.

The order for the 600 cars for the Pittsburgh, Bessemer & Lake Erie Railroad, mentioned last month, has been given to the Schoen Pressed Steel Company, of Pittsburgh. The order is a notable one, as the cars are to be of steel, 300 to be built from designs furnished by engineers of the Carnegie Steel Company, and 300 from the designs of Mr. Chas. T. Schoen. One-half of the cars will be equipped with the Schoen Pressed Steel Company's design of truck, and of the balance 200 are to be equipped with Fox truck, 50 with the Kindl, 30 with the Cloud, 10 with the Goltra and 10 with the Vogt truck. The cars are all to be of 100,000 pounds' capacity.

In addition to the twenty-one locomotives which the Brooks Locomotive Works are building for the Mexican Central Railway, they have under construction four 16 by 22-inch side tank passenger locomotives for the Koya Railway, of Japan; two 18½ by 24-inch American type passenger locomotives and two 6-wheel switching locomotives for the Chicago, Indianapolis & Louisville; three 18 by 26-inch American type passenger locomotives for the St. Lawrence & Adirondack Railway; two 10-wheel passenger locomotives for the Burlington, Cedar Rapids & Northern Railway; three moguls for the Pittsburgh, Bessemer & Lake Erie Railway; three Mastodon type freight locomotives for the Buffalo, Rochester & Pittsburgh Railway, and several smaller orders.

A contract has been closed by the Pencoyd Iron Works for 165 steel bridge spans for the Imperial Japanese Railway. This is an important fact, not on account of the size of the order, but because the contract was taken in competition with English and Belgian manufacturers. The price was not a special one, but it was made at the ruling rate for that class of material. It is evidence that the conditions now existing are such that the American steel manufacturers can successfully compete with foreign manufacturers. This is owing to improved mill methods and reduced cost of material in this country, the cost of labor not being a governing element. These, it is said, will be the first bridges built in this country for Japan, and it is believed that this order is but the beginning of an export trade from the United States in steel work for bridges and buildings. The bridges contracted for are for a new line of railways.—Philadelphia Ledger.

The United States Court for the Northern District of Ohio (Judge Taft) has decided the case of the St. Louis Car Coupler Company vs. The National Malleable Castings Company in favor of the latter company, declaring that the Tower coupler was not an infringement of the Lorraine & Aubin reissued patent No. 10,941, June 26, 1888. The three features which were claimed to be covered by this patent were the shape of the knuckle, the position of the pivot pin and the riding of the lock on the tail of the knuckle. The Court held that none of these were novelties in themselves, and that because of the prior state of the art only the narrowest construction must be put upon the claims of the patent. The combination claims were not infringed if a single element were omitted. Several arguments, based on the validity of the reissued patent, were not passed on by the Court, because it was held that even, if valid, there was no infringement of them.

In an article on American and European wheel practice for street railways by Mr. P. H. Griffin, in the Street Railway Journal, says: There are in America about 14,000 miles of electric railways and 40,000 cars in service, 75 per cent. of the latter having four and about 25 per cent. having eight wheels per car. This makes a total of about 200,000 wheels in this kind of service. Of this total no t 1

per cent. are steel or steel tired wheels. It can, therefore, be fairly said that whatever the probabilities are for the use of steel wheels on American electric railways, they have not, up to the present time, made much progress in that direction. This is not stated to the detriment of the steel wheel or its makers, but as a simple fact. It is the opinion of some engineers abroad that the chilled wheel is used in America because it is cheap, but that is far from the fact. American electric railways of the best class do not stop at any expense that will improve service and give better results, and certainly in no country has the development and operation of electric railways been carried to the high standard that it has in this country.

The Pintsch gas buoys used in the St. Lawrence River last year have given such excellent satisfaction that an additional appropriation has been secured from Congress for several more buoys to be placed the coming season. Canadian papers are strongly advocating an appropriation for the purchase of the buoys for Canadian waters. The Pintsch buoy is a compact wrought iron vessel filled with compressed Pintsch gas, and carrying at its top a patent storm proof lantern supported by a strong iron framework. The flow of gas from the reservoir into the lantern is controlled by the Pintsch regulator, by means of which a clear light is maintained, no matter what may be the position of the buoy or how much it may toss in heavy seas. The storm proof lantern is so constructed that while the necessary air is admitted to feed the flame, not a particle of water can enter. The buoys are of various sizes and burn continuously and reliably night and day for from three months to one year, depending on their size. The refilling of a buoy is done from a tender by passing compressed Pintsch gas through a flexible tube into the buoy. This gas is the same as is now used in railroad arc lighting.

The Standard Oil Company are about to erect at Bayonne, N. J., a boiler shop 300 feet long and 105 feet wide. The main portion of the shop is divided into three bays. The central bay, about 50 feet wide, is served with a 15-ton electric crane, supported on heavy girders about 40 feet above the floor. On either side of this main portion is a wing about 30 feet wide. The walls of the building are brick and the supporting frame work is steel. The roofs are to be covered with corrugated iron. The main columns of the shop are 25 feet apart and all arranged so that jib cranes of suitable size and capacity can be attached at any point, which together with the traveling crane in the center will enable them to cover the entire floor surface of the building. One end of the building for a distance about 75 feet in length is supported by clear span trusses which gives a clear floor space over this entire area. In this end of the building will be located fires and furnaces, and other apparatus for heating and shaping the material for the boilers. The building is well lighted by windows in the sides of the brick walls and in the monitors of the roof, and is amply ventilated by means of large monitors on the ridge.

The vises manufactured by the Howard Iron Works, of Buffalo, N. Y., are noted for their great strength, durability, and their excellent construction. The malleable cast-iron nut of the vise is rendered immovable by being set in molten iron, thereby doubling the durability of both nut and screw, for they are saved from the destructive grinding, cutting and binding action of the cross-strain, which has always been a great evil heretofore. Another improvement is the chilling of those parts of the slide sheath, that come in contact with the slide, thereby avoiding much friction in its movement. Many additional and important improvements have also been made in their swivel vise. There is great strength in its circular base, so that its side parts may be employed for light anvil uses. The vise is held fast to bench by a very simple cam arrangement, holding it so firmly that the combined force of several men exerted upon the vise cannot move it from position; and yet so convenient is the arrangement that this great power is instantly removed and applied. The seat of the swivel is slightly concave, so that it shall rest upon the circumference of its base. Their universal combination vises are very handy mechanical appliances for general use, as they combine two different and separate vises in one. They are made very strong, and will swivel in any direction. The "Combination Pipe and Metal Workers' Vise" will be found a very useful and practicable instrument in every engine-room, etc., as the engineer with the aid of a few pipe tongs and die plates, can in most cases do all the small repairing and fitting of pipes, etc., himself. The Howard Iron Works have recently issued a neat folder descriptive of these and other vises of their manufacture.

Our Directory

OF OFFICIAL CHANGES IN APRIL.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Mobile & Ohio.—Mr. E. L. Russell has been elected Vice-President.

Brooklyn Elevated.—Mr. F. K. Ulman has been appointed Receiver.

Plant System.—Mr. J. F. Sheahan, Master Mechanic at Palatka, Fla., has resigned.

Kansas City, Pittsburgh & Gulf.—President E. L. Martin has resigned, and Vice-President A. E. Stillwell succeeds him.

Wilmington, Newbern & Norfolk.—Vice-President H. A. Whiting has been appointed Receiver.

Fall Brook.—Col. John Magee has been elected President, to succeed Gen. G. J. Magee, deceased.

Allegheny & Kinzua.—Mr. F. W. Kruse has been appointed Receiver, vice Mr. A. D. Scott.

Rio Grand Western.—Mr. John Hickey has been appointed General Master Mechanic, with office at Salt Lake City.

Fonda, Johnstown & Gloversville Railroad.—The Hon. James Shanahan, President of the Fonda, Johnstown & Gloversville Railroad, died on March 12, 1897.

Gainesville, Jefferson & Southern.—Mr. S. C. Dunlap has been appointed Receiver, vice Mr. Martin H. Dooly.

Wadley & Mt. Vernon Railroad.—Mr. T. J. James has been elected President.

Mexican Central.—Mr. H. Ridgeway has been appointed Master Mechanic at Chihuahua, vice Mr. T. Smethurst, resigned.

Ann Arbor.—Mr. O. D. Richards is appointed Chief Engineer, vice Mr. G. A. Nettleton, resigned.

Kansas City & Northern Connecting.—Mr. T. C. Sherwood has been appointed General Manager.

Houston, East & West Texas.—Mr. E. B. Cushing has been appointed Chief Engineer.

Roaring Creek & Charleston.—Mr. Thomas Fisher has been appointed Receiver, vice Mr. C. T. Dixon, resigned.

Lehigh Valley.—Mr. F. F. Gaines has been appointed Mechanical Engineer, vice Mr. H. D. Taylor, promoted.

Lexington & Eastern.—Mr. Geo. F. Foster has resigned as Master Mechanic and the office is abolished. Mr. E. R. McCuen has been appointed General Foreman in charge of Mechanical Department. Headquarters, Lexington, Ky.

Dunkirk, Allegheny Valley & Pittsburgh.—The position of Master Mechanic, made vacant by the death of Mr. W. G. Tabor, has been abolished. Mr. A. Sherman is Foreman of Repairs at Dunkirk, N. Y.

St Louis & Cairo.—Mr. F. A. Horsey has been elected President, vice Mr. J. H. Horsey, deceased.

Philadelphia & Reading.—Mr. Albert Foster, Purchasing Agent, died April 10.

South Beach.—Mr. Chas. A. Beach has been chosen General Manager.

Carolina & Northwestern.—Mr. G. W. F. Harper has been chosen President.

Gulf, Colorado & Santa Fe.—Mr. L. J. Polk, Acting General Manager, has been made General Manager.

Cornwall.—Mr. D. S. Hammond, Purchasing Agent, died on April 3.

Queen Anne.—Mr. I. W. Troxell has been chosen General Manager. Office, Queenstown, Md.

Oregon Short Line.—Mr. J. F. Dunn is Superintendent of Motive Power and Ira O. Rhodes, Purchasing Agent.

Eastern of Minnesota.—General Manager W. C. Farrington has resigned and Vice-President J. N. Hill will perform the duties of the office.

Atlantic & North Carolina.—Mr. Robert Hancock has been elected President.

Norfolk & Western.—Mr. Joseph H. Sands has resigned as General Manager and the duties of the office will be performed by Vice-President J. M. Barr.

Chicago & Northwestern.—Mr. W. H. Marshall is appointed Assistant Superintendent of Motive Power and Machinery, with office in Chicago.

Chicago, Burlington & Quincy.—Master Mechanic Mr. Joel West died March 23d. Master Mechanic C. W. Eckerson died April 9th. Mr. J. F. Deems has been transferred from Ottumwa to Beardstown. Mr. J. E. Button has been appointed Master Mechanic at Ottumwa.

New Albany, Lebanon & Sodaville.—Mr. M. W. Wilkins is President, with headquarters at Waterloo, Oregon.

Chicago & Grand Trunk.—Mr. George Masson, chief engineer, has resigned. Mr. J. W. Harkom has been appointed Master Mechanic of the Eastern Division with office at Montreal; Mr. W. D. Robb, Master Mechanic, of the Middle Division, with office at Toronto, and Mr. Wm. W. Ball, Master Mechanic of the Northern Division, with office at Allandale, Ont.

Atchison, Topeka & Santa Fe.—Mr. W. E. Hodges has been appointed Purchasing Agent, vice Mr. W. G. Nevin, resigned.

Southern California.—Mr. W. G. Nevin, formerly Purchasing Agent of the A., T. & S. F., has been chosen General Manager, vice Mr. K. H. Wade, deceased.